Otter Brook
New Hampshire

Otter Brook Lake Dam-Break Flood Analysis

AUGUST 1985

US Army Corps of Engineers
New England Division

OTTER BROOK LAKE
CONNECTICUT RIVER BASIN
NEW HAMPSHIRE

DAM-BREAK FLOOD ANALYSIS
BY
HYDRAULICS AND WATER QUALITY SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

AUGUST 1985

DAM-BREAK FLOOD ANALYSIS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

OTTER BROOK LAKE PROJECT
DAM-BREAK FLOOD ANALYSIS

1. INTRODUCTION AND PURPOSE

This report presents the findings of a dam-break flood analysis performed for the Otter Brook Dam, an existing Corps of Engineers flood control project, which is located at Keene, New Hampshire on Otter Brook, the principal tributary of the Branch River, which in turn is a tributary of the Ashuelot River. The dam site is situated 4.9 miles above the confluence of the Branch with the Ashuelot River and about 31 miles upstream from the Ashuelot River's confluence with the Connecticut River at Hinsdale, New Hampshire. Included in the report are a description of the pertinent features of the dam, the procedure used for the analysis, the assumed dam-break conditions and resulting effect on downstream flooded areas, and the effects of varying conditions (sensitivity tests) on the resulting downstream flood. This study was not performed because of any known likelihood of a dam-break at Otter Brook Dam. Its only purpose was to provide quantitative information for emergency planning use in accordance with Corps of Engineers Regulations (ER 1130-2-419).

2. PROCEDURE

The Otter Brook dam-break analysis was made using the "National Weather Service Dam-Break Flood Forecasting Computer Model", developed by D. L. Fread, Research Hydrologist, Office of Hydrology, National Weather Service, NOAA, Silver Spring, Maryland 20910. Input to the model consisted of: (a) storage characteristics of the reservoir, (b) selected geometry and duration of the breach development, and (c) hydraulic characteristics of the downstream river channel including tributary inflows, hydraulic roughness coefficients, and active and inactive flow regions. Based on the input data, the model computes the dam-break outflow hydrograph and routes it downstream. Dynamic unsteady flow routing is performed by a "honing" iterative process governed by the requirements of both the principles of conservation of mass and momentum. The analysis provides output on the attenuation of the flood hydrograph, resulting flood stages, and timing of the flood wave as it progresses downstream.

The approach used in this hypothetical dam-break analysis was to first apply the model using a selected set of conditions thought to be reasonably possible in a failure situation. The flood wave resulting from this analysis is termed the Base Flood condition. Because any one of the major variables used in the model (initial pool elevation, antecedent riverflow, time of breach development, etc.) could in fact have different values or occur in different combinations from those used in the Base Flood determination, sensitivity analyses were employed to determine the effects that changed values of these parameters have upon the resulting flood wave.

Calibration of the model was accomplished by comparing computed stage-discharge relationships with those known to exist at various locations along the river reach being modeled (i.e., at dams, streamflow gages, high watermarks, etc.).

3. DESCRIPTION OF STUDY AREA

a. General. The study area extends from Otter Brook Dam, downstream along Otter Brook, the Branch River and the Ashuelot River to the Connecticut River, a distance of 31 river miles. Along the study reach, the drainage area increases from 47 square miles at Otter Brook Dam to 421 square miles at the mouth of the Ashuelot River. Major tributaries in the Ashuelot River basin include the Branch and South Branch Ashuelot Rivers. In addition to Otter Brook Dam, another Corps flood control project, Surry Mountain Dam, is located on the Ashuelot River five miles upstream from Keene, New Hampshire. Both provide flood protection for the local communities along the Ashuelot and desynchronize floodflows on the Connecticut River. Both are sources of water-based recreational facilities. A map of the Ashuelot River basin is shown on plate 1 and a map showing the relationship of the Ashuelot River projects to the Connecticut River basin is provided on plate 2.

b. Otter Brook Dam. This dam, constructed in the city of Keene, New Hampshire by the Corps of Engineers as a single-purpose flood control project, was placed in operation in April 1958. Later, recreational activities were included as part of the reservoir management program. The project is 1 of 2 flood control reservoirs in the Ashuelot River basin and 1 of 16 flood control reservoirs within the Connecticut River basin which were built by the Corps of Engineers. Otter Brook Dam is a rolled earth embankment structure, 1,288 feet in length and has a maximum height of 133 feet. Top width of the dam is 25 feet and the side slopes are 1V on 2.5H. A photo, general plan and cross section through the outlet works are shown on plates 3, 4 and 5. When filled to spillway crest elevation, the reservoir has a flood control capacity of 17,680 acre-feet, which is equivalent to 7.0 inches of runoff from the 47-square mile upstream drainage area. The reservoir length formed by this 274 acre pool is about 2.3 miles. Other pertinent data are listed in table 1.

c. Downstream Valley. Otter Brook joins Minnewawa Brook about 2.4 miles downstream from Otter Brook Dam to form the Branch River. The Branch joins the Ashuelot River just downstream from its confluence with Beaver Brook and nearly 5 miles downstream from the dam. The Ashuelot River travels through three communities, Keene, Swanzey and Winchester, in downstream order, prior to reaching the Connecticut at Hinsdale. Through this reach, the river normally ranges from 50 to 100 feet in width. The flood plain is generally less than 1,000 feet in width except for the reach about 7 miles before Dickinson Dam, which is as wide as 13,000 feet.

The channel of Otter Brook and the Branch is steep and conducive to rapid runoff, falling about 210 feet in the first 5 miles downstream from Otter Brook Dam, with an average gradient of 53 feet/mile. An unnamed dam at river mile 3.5 is breached at elevation 499.8 feet, NGVD. This structure would have no effect on the dam failure flood wave levels and was therefore ignored.

Between river miles 5 and 9 the Ashuelot River channel meanders with a relatively small channel cross sectional area and significantly flatter gradient forming the Keene flood plain, the most predominant feature of the Ashuelot River watershed. Average gradient in this area is about 2.5 feet/ mile. Additionally, inflows from Ash Swamp Brook and the South Branch Ashuelot River contribute to discharges on the Ashuelot River in the Keene flood plain area. Incoming floodwaters are ponded in the flood plain, attenuating resultant flows downstream.

TABLE 1

OTTER BROOK LAKE PROJECT PERTINENT DATA

Location:	Otter Brook, Keene, New Hampshire	
Drainage Area:	47 square miles	
Reservoir:	Outlet Works Intake (Invert)	683 feet NGVD
	Recreation Pool	701 feet NGVD
	Flood Control Pool (Spillway Crest)	781 feet NGVD
Dam:	Type	Rolled earth fill
	Length	1288 feet
	Top Width	25 feet
	Top Elevation	802 feet NGVD
	Maximum Height	133 feet
Spillway:	Type	Uncontrolled, ogee weir, chute spillway
	Length	145 feet
	Crest Elevation	781 feet NGVD
	Surcharge	17.3 feet
	Capacity	40,000 cfs
Outlet Works:	Type	Boston horseshoe-shaped conduit
	Length	589 feet
	Gates	Hydraulic Slide
	Number	3
	Size	2'6" x 4'6"
	Normal Regulated Maximum Discharge	600 cfs
	Maximum Capacity at Spillway Crest	1,320 cfs

The average Ashuelot River gradient remains about 2.5 feet/mile until river mile 24.2 where the invert drops 245 feet in the last 5.3 miles for an average slope of 46 feet/mile to the Connecticut River. The Connecticut River from the Ashuelot River to Turners Falls Dam in Turners Falls, Massachusetts is much flatter with an average slope of about 2 feet/mile. Turners Falls Dam and the adjacent French King Gorge create a backwater effect which extends upstream into the Ashuelot River and controls stages at its lower end, below the Hinsdale and Fiske Paper Company Dam.

Otter Brook, the Branch River and the Ashuelot River are crossed by numerous state highways, railroad lines and local roads. These crossings are indicated on plan and profile sheets 1 through 3 (plates 6 through 8). Following is a brief description of the downstream dams in their order of appearance:

(1) Dickinson Dam (also known as the Homestead Woolen Mill Dam). Located about 12.5 miles downstream from Otter Brook Dam, in Swanzey, New Hampshire, this wooden crib structure has a length of about 170 feet. With a height of about 16 feet, it has a maximum impounding capacity of about 700 acre-feet. Maximum discharge over the 160-foot long uncontrolled spillway is approximately 7,500 cfs. The upstream drainage area of 312 square miles includes the vast Keene flood plain area.

(2) New England Box Company Dam. With an upstream drainage area of 355 square miles, this dam, located in Winchester, New Hampshire, about 22.5 miles downstream from Otter Brook Dam, has a crest length of approximately 100 feet. With a height of 8 feet, it has a maximum impounding capacity of 75 acre-feet.

(3) Public Service Company Dam (also known as Upper Robertson Dam). This dam, existing in a partially breached condition, is located about 26.2 miles downstream from Otter Brook Dam, in Winchester, New Hampshire. The drainage area is about 393 square miles and the dam height is about 5 feet.

(4) Public Service Company Dam (also known as Robertson Dam). This rock-filled timber crib dam located in Winchester, New Hampshire, about 26.8 miles downstream from Otter Brook Dam, has an overall length of 150 feet

and maximum height of 17 feet. The overflow section is about 100 feet long and about 12 feet above the downstream channel invert. The upstream drainage area is about 406 square miles. Spillway capacity with the water surface at top of dam is approximately 5,300 cfs. Top of dam and spillway crest are at about elevations 388 and 383 feet NGVD, respectively. Maximum storage at top of dam is 112 acre-feet.

(5) Ashuelot Paper Company Dam. Located about 27.5 miles downstream from Otter Brook, in Winchester, New Hampshire, this rock-filled timber crib overflow dam has a length of about 120 feet and height about 10 feet above downstream river bottom. Maximum storage capacity is 220 acre-feet and the drainage area at the dam is 410 square miles.

(6) Canal Company Dam. This dam is located in Hinsdale, New Hampshire about 28.4 miles downstream from Otter Brook Dam. It has a spillway crest about 8 feet above the downstream river channel invert.

(7) Hinsdale and Fiske Paper Company Dam. Situated about 29.2 miles downstream from Otter Brook Dam with an upstream drainage area of 412 square miles, this dam has a maximum height of about 15 feet. Maximum storage capacity is 100 acre-feet at top of dam. With a crest length of about 165 feet, the maximum spillway capacity is 6,500 cfs with the water surface at top of dam.

(8) Turners Falls Dam. This dam is located in Turners Falls, Massachusetts on the Connecticut River about 18 miles downstream from the confluence with the Ashuelot River. Used for hydroelectric generation, backwater from this dam and the adjacent French King Gorge control stages in the lower reach of the Ashuelot River. The drainage area at the dam is 7,163 square miles. Normal operating pool at the dam ranges from 175 to 185 feet NGVD. Total storage is 21,500 acre-feet, and the reservoir length is 19.7 miles.

4. ASSUMED DAM-BREAK CONDITIONS

a. General. The magnitude of a flood resulting from the hypothetical failure of Otter Brook Dam is a function of many different parameters including size of the dam and reservoir, size of the breach, initial pool level, rate of breach formation, channel and overbank roughness and antecedent flow conditions. Engineering assumptions of conditions which could reasonably be expected to exist prior to a failure of Otter Brook Dam and which were used in the Base Flood analysis are presented below.

b. Selected Base Flood. Parameters and their values used in the Base Flood profile analysis are given in the following tabulation:

Pre-breach Flow - Otter Brook, Ashuelot River: flow resulting from the flood of 21-23 September 1938 after routing through flood control storage. Connecticut River: peak flow associated with the modified flood of 18-21 March 1936.

A constant flow rate of 1,500 cfs from Otter Brook Dam, slightly higher than the maximum outlet works capacity with the pool at spillway crest, was used for this study to provide computational stability in the numerical solution technique. This discharge was used only to provide a valid computer solution; this does not reflect the normal operational procedure at the dam. The peak elevation flood profile resulting from an antecedent flow of 600 cfs, the maximum normal regulated discharge, would be almost identical.

Initial Pool Level - Otter Brook Dam: water surface at spillway crest elevation 781.0 feet, NGVD.

Breach Invert - Elevation 688 feet, NGVD

Breach Dimension - Width = 225 feet: Side slopes = 2V on 1H

Time to Complete Formation of Breach - 1 hour

Downstream Channel Roughness - Manning's "n" values used range between 0.02 and 0.12

Downstream Dam Failure - Due to their small impoundments and heights all downstream dams on the Ashuelot River were assumed to remain intact. Turners Falls Dam on the Connecticut River was also assumed to remain intact.

5. RESULTS

The resulting peak stage flood profile and the areal extent of inundation for the Base Flood conditions are shown on plates 6 through 8. Timing of the peak stage and leading edge of the flood wave are also indicated on the plan and profile. Peak discharges throughout the study reach associated with the development of the peak stage profile along with discharge and stage hydrographs for three stations downstream from Otter Brook Dam are shown on plate 9. The stations are located 3.3, 12.4 and 29.1 miles downstream from the dam.

The peak dam-break discharge from Otter Brook Dam would be about 317,000 cfs, producing a rise of about 30 feet above the normal river depth at a point 0.3 mile downstream from the dam. From Otter Brook Dam to the beginning of the Keene flood plain, a distance of about 3.3 miles, the peak flow would attenuate to a flow of 270,000 cfs and the river rise would be up to approximately 46 feet above normal river stage. Just upstream from Dickinson Dam (river mile 12.4), the peak flow would reduce to 29,900 cfs with a resultant peak stage of about 10 feet above normal stage. At the Hinsdale Dam (river mile 29.1), the wave would attenuate to a flow of 23,700 cfs with an attendant maximum rise over normal depth of about 8 feet. Most of the flood wave attenuation occurs in the Keene flood plain area between 3.4 and 8 miles downstream from Otter Brook Dam.

With the conservative assumption of a coincident peak stage on the Connecticut River due to the modified March 1936 flood event, the rise above normal at the mouth of the Ashuelot River would be about 31 feet. However, only about 1.7 feet of this rise would be attributed to the 23,700 cfs flow in the Ashuelot River. The remainder is due to backwater from the Connecticut River caused by Turners Falls Dam and the French King Gorge.

The dam-break analysis was terminated at the mouth of the Ashuelot River since the water surface elevation produced from the dam-break flood analysis was less than the experienced March 1936 high watermarks at this point.

6. SENSITIVITY TESTS

In addition to the analysis under the assumed Base Flood conditions, subsequent studies were made to determine the sensitivity of certain selected parameters on the resulting downstream flood. These were made by applying the model to the same data set used for the Base Flood except that one parameter was varied in each simulation. Following is a listing of the variables used in the sensitivity testing and a discussion of the results of each test.

a. Antecedent Flow Conditions. Base Flood analysis assumed a high flow already occurring in the river at the time of dam-break. This was considered appropriate since if a breach were to occur, it is quite conceivable that it would do so at a time of abnormally high flow conditions. Antecedent flow conditions on the Ashuelot River were selected to equal the recurring record September 1938 floodflows as modified by the existing system of Corps of Engineers flood control reservoirs, namely, Surry Mountain and Otter Brook projects. At the confluence of the Ashuelot River with the Connecticut River, the stage associated with the March 1936 flood, as modified by the upstream Corps flood control reservoirs (Surry Mountain, Otter Brook, Townshend, Ball Mountain, North Springfield, North Hartland and Union Village Dams) was conservatively used.

Specifically, model input data for inflow into Otter Brook Reservoir consisted of the recessional side of the natural September 1938 flood hydrograph which was then routed through the reservoir assuming the pool was already filled to spillway crest level during the rising side of the same hydrograph. The initial and peak inflow and outflow from Otter Brook Dam's regulating gates were assumed to be constant at 1,500 cfs. This outflow was only used to provide computational stability in the numerical simulation technique and does not reflect the normal operational procedure at the dam. The peak elevation flood profile resulting from an antecedent flow of 600 cfs, the maximum normal regulated discharge, would be almost identical.

Inflows from Minnewawa and Beaver Brooks, the Ashuelot River, Ash Swamp Brook, the South Branch River and a local drainage area all of which enter 2.4, 3.8, 4.9, 6.1, 8.0 and 23.3 miles downstream from Otter Brook Dam, respectively, were also accounted for in the dam-break hydrograph routing analysis. September 1938 hydrographs for each stream were initiated at their respective rates coincident with the peak inflow to Otter Brook Dam and then continued through their accessional and recessional phases as appropriate, for the remainder of the routing analysis. Peak inflows were 3,500, 1,100, 3,700, 3,000, 9,500 and 1,100 cfs, respectively. Inflows from the Ashuelot River included the modifying effect of Surry Mountain Dam.

Antecedent inflow from the Connecticut River basin below the Ashuelot River confluence was conservatively accounted for by using the March 1936 peak flow as modified by the upstream system of flood control reservoirs.

The adopted initial antecedent flows and the comparative experienced 1938 and 1936 discharges, as applicable, are shown in table 2.

A sensitivity analysis was made assuming lower antecedent riverflows and the resulting comparative flood stages are shown on plate 10. Discharges occurring prior to onset of the 1938 flood, which were assumed to remain constant, were used as the antecedent conditions for this sensitivity test. As can be seen in the profile, although there is a substantial difference in stage between the two antecedent conditions, the resulting dam-break flood profiles show close agreement for the first 4 miles below Otter Brook Dam, thus indicating there is little sensitivity to initial flow conditions in the dam-break analysis in the reach close to the project. However, from this point downstream the difference becomes greater with the profile for the dam-break flood with low antecedent flow coinciding with the high antecedent flow profile at about river mile 24. This is primarily due to the reduced tributary inflow volumes.

b. <u>Breach Width</u>. The breach width was set at 225 feet for the Base Flood analysis. For sensitivity testing, two additional cases were evaluated. As shown by the comparative profiles on plate 11, the stage dropped by up to 4 feet in the first four miles downstream from the dam for a breach width of 150 feet. For a failure width of 275 feet, the inundation stage was raised up to 2 feet

TABLE 2

ANTECEDENT FLOODFLOW CONDITIONS

Location	Adopted Antecedent Flows*	Experienced Record Floods Flow (cfs)	Experienced Record Floods Date
Otter Brook			
Roxbury, NH (inflow to dam)	6,150	6,150	Sep 1938
Ashuelot River			
Keene, NH (5.1 miles downstream from Otter Brook Dam)	3,700	7,600**	Sep 1938
Swanzey, NH (14 miles downstream from Otter Brook Dam)	10,500	16,000**	Sep 1938
Hinsdale, NH (29.1 miles downstream from Otter Brook Dam)	11,900	16,200**	Sep 1938
Connecticut River			
Hinsdale, NH (30.0 miles downstream from Otter Brook Dam)	145,600***	192,600**	Mar 1936

* Flow rate at instant of breach initiation

** Estimated peak flow rate, not simultaneous with initial Otter Brook reservoir inflow rate.

*** It was conservatively assumed for purposes of this failure routing that this flow would be occurring on the Connecticut River simultaneously with the dam failure flood wave reaching the mouth of the Ashuelot River.

in the first 2 miles downstream from the dam. These differences diminished to virtually nothing further downstream in both instances.

c. Failure Time. The selected duration of the breach development for the Base Flood condition was one hour. For sensitivity assessment, analyses were also made with failure times of 0.5 and 2.5 hours. These breach development durations resulted in the inundation stages shown on plate 11. The shorter time for breach formation resulted in the stage increasing up to 5 feet in the first 4 miles. In the same reach, the longer failure time caused stages to fall as much as 8 feet. In both instances the ponding in the Keene flood plain and the dam at river mile 12.5 controlled the flows such that there were essentially no changes in stage beyond river mile 5.0 for the alternative durations.

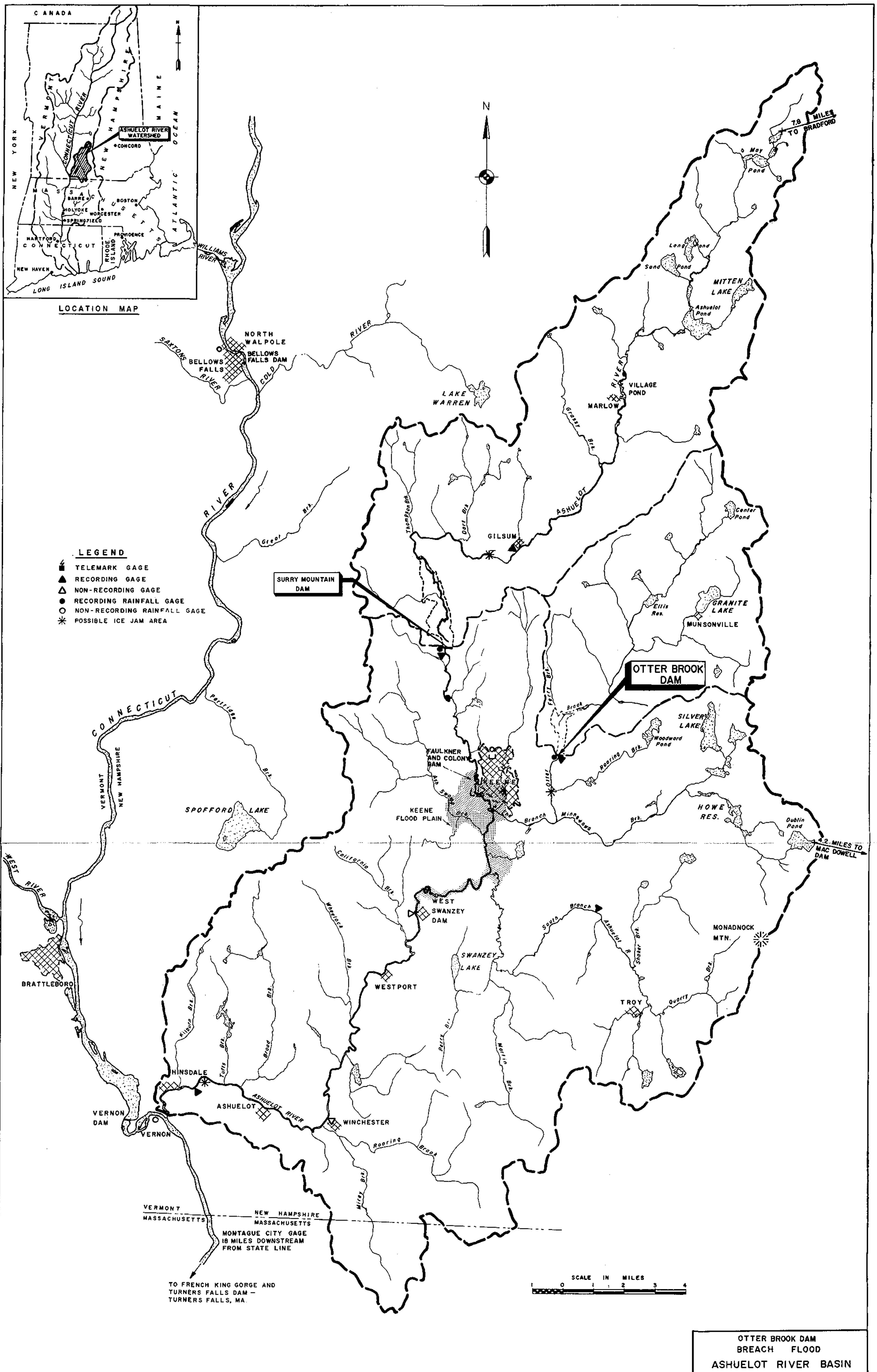
d. Initial Pool Level. While a full reservoir condition (spillway crest, elevation 781 feet NGVD) was assumed for the Base Flood, a test of the sensitivity of the dam-break flood to initial pool level was made assuming a one-half full pool condition (elevation 735.0 feet NGVD).

The analysis shows that discharge would decrease by 63 percent immediately below the dam. Comparative water surface profiles are shown on plate 12. Drops in stage between 10 to just under 30 feet resulted in the first four miles. From the Keene flood plain to the end of the study at Hinsdale stage reductions were 2 to 4 feet.

e. Channel Roughness. Sensitivity tests were made to determine the effect of Manning's "n" value on downstream flood attenuation, resulting stages and timing. Tests were made with Manning's "n" values 10 percent greater and 10 percent less than that used in the Base Flood condition. Lowering the channel roughness (smaller "n" value) resulted in faster movement of the flood wave and less attenuation. Increasing the channel roughness (greater "n" value) resulted in the reverse occurring. However, as illustrated on plate 13, the resulting variations in the downstream profiles were negligible. The most significant effect of varying the channel roughness was the difference in timing of the peak flood stage. At the lower end of the Ashuelot River, in Hinsdale, this timing varied from approximately 15-1/2 to 17-1/4 hours for the lowest and highest "n" values, respectively. By comparison, the time of the peak flood stage at Hinsdale for the base flood is about 16-1/4 hours.

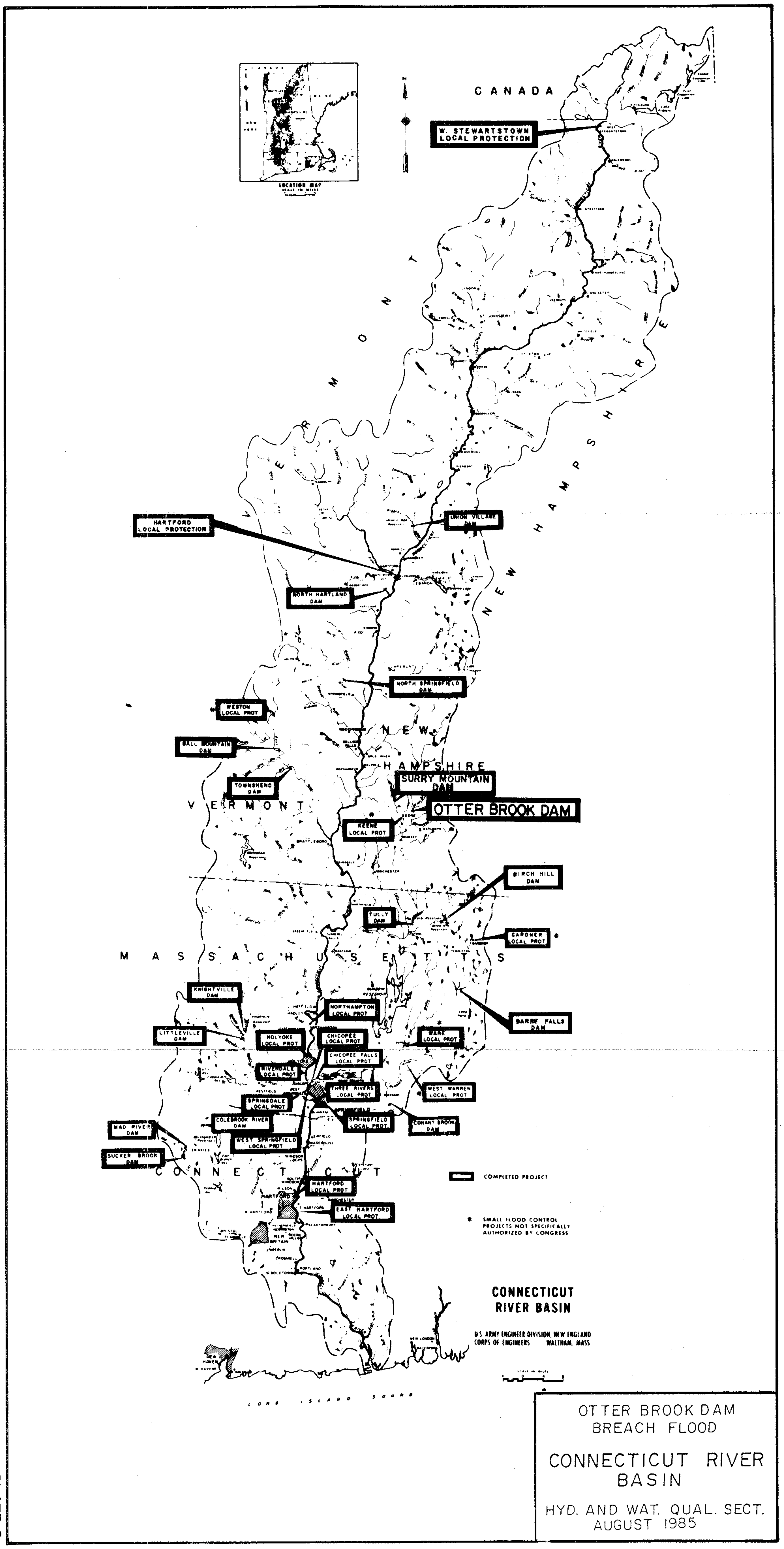
7. DISCUSSION

The dam-break analysis for Otter Brook Dam was based on the engineering application of certain laws of physics, considering the hydrologic and hydraulic characteristics of the project and downstream channel, and conditions of failure. Due to the highly unpredictable nature of a dam-break and the ensuing sequence of events, results of this study should not be viewed as exact but only an approximate quantification of the dam-break flood potential. For purposes of analysis, downstream conditions are assumed to remain constant and no allowance is made for possible enlargement or relocation of the river channel due to scour or the temporary damming effect of debris all of which affect, to some extent, the resulting magnitude and timing of flooding downstream.



OTTER BROOK DAM
BREACH FLOOD
ASHUELOT RIVER BASIN
HYD. AND WATER QUALITY SECTION
AUGUST 1985

PLATE 1

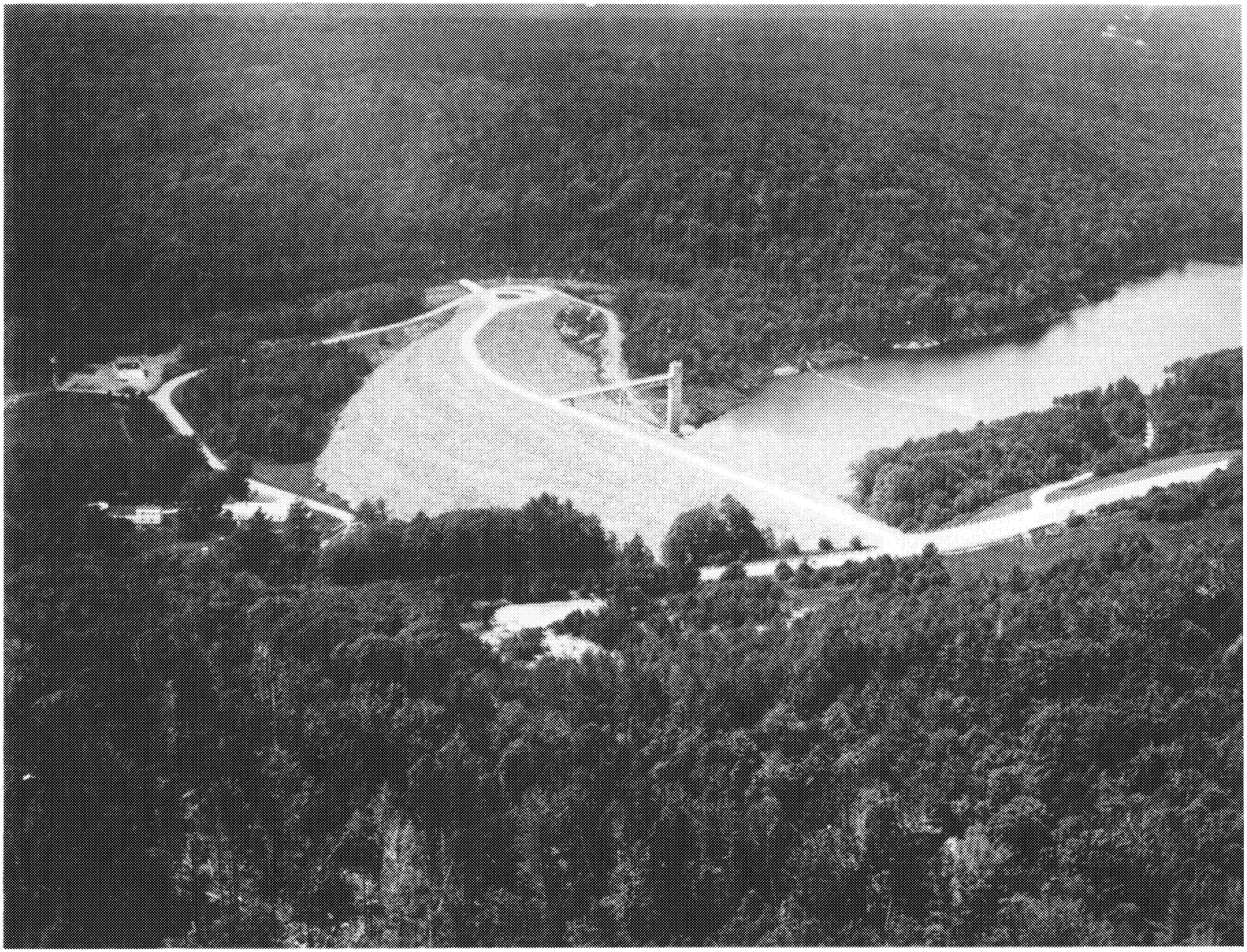


OTTER BROOK DAM
BREACH FLOOD

CONNECTICUT RIVER BASIN

HYD. AND WAT. QUAL. SECT.
AUGUST 1985

PLATE 2

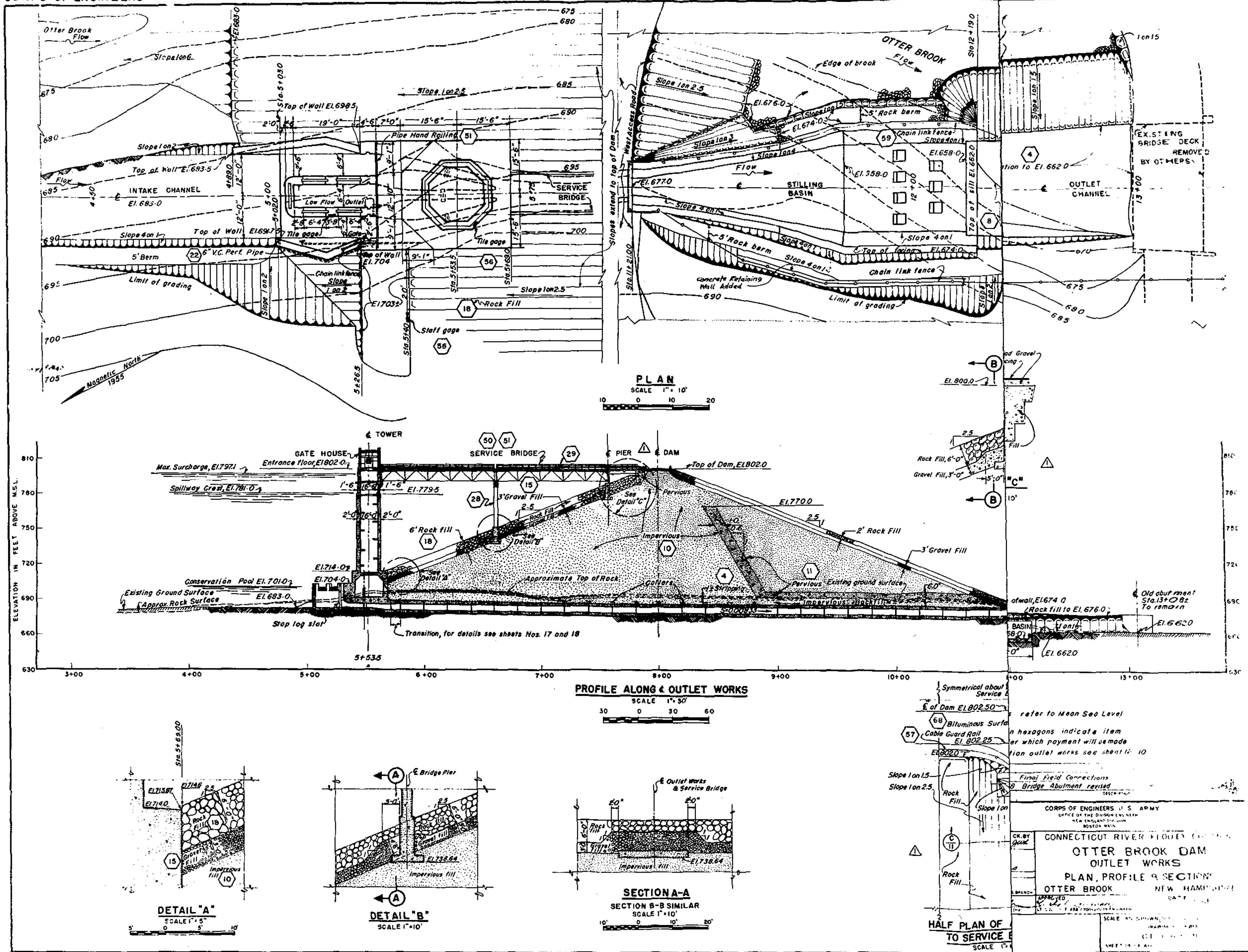


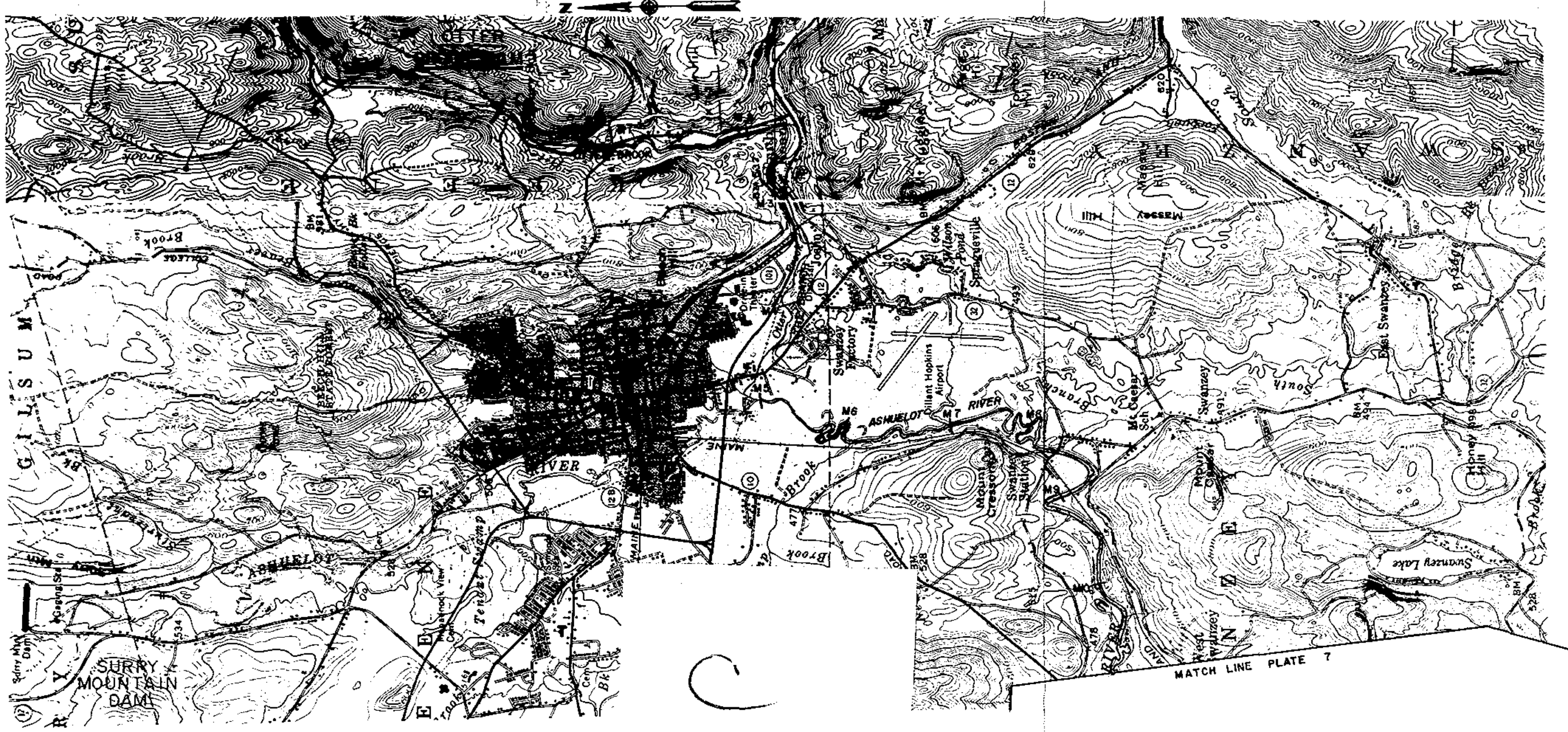
U.S. Army Corps of Engineers

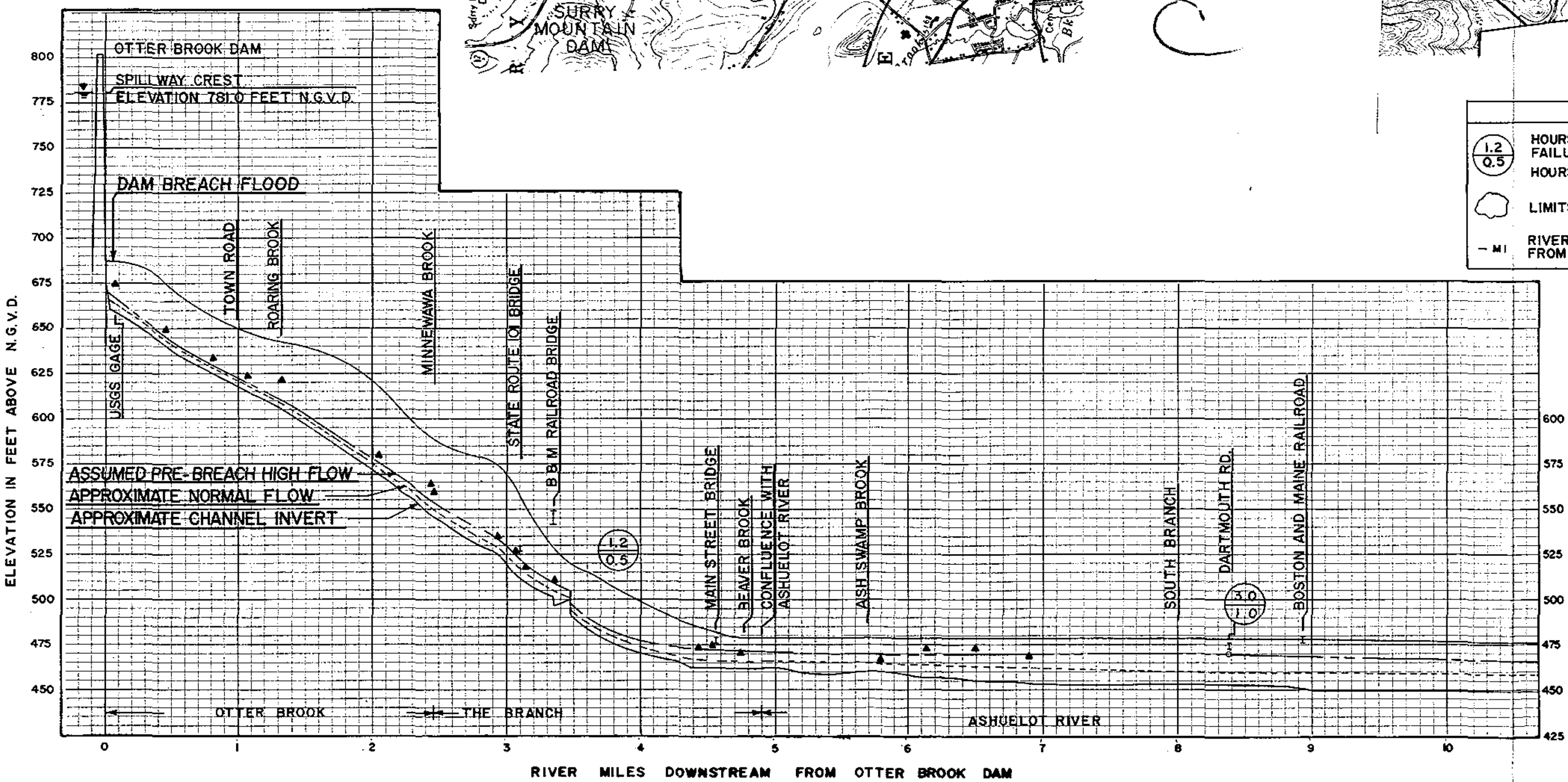
VIEW OF OTTER BROOK LAKE

PLATE 3


MATCH LINE A-A
LIMIT OF RESERVOIR CLEARING
LIMIT OF CONTRACTOR'S WORK AREA
Magnetic North 1955
Note: For Details of Spillway see Sheet No. 12.
Right Bank Log Boom Anchor, Steel Pile grouted in rock
LOG BOOM
Left Bank Log Boom Anchor, Steel Pile
Davis Road
Existing Culvert 18" RC Pipe
SPOIL BLANKET
Power & Telephone lines to be relocated by others
INTAKE STRUCTURE
SERVICE BRIDGE
DAM
℄ DAM
Existing Davis Road Relocation See Sheet No. 57
SPILLWAY CHANNEL
OUTLET CONDUIT
WEST ACCESS ROAD
ROAD BARRICADE
PEG SHOP RD.
To Keene
Existing Building To Be Removed
SPOIL AREA
OPERATORS QUARTERS (By Others) (Existing)
UTILITY BLDG.
Rock Fill
PIEZOMETERS (By Others)
Bridge to be removed by others
BANK PROTECTION See Typical Section Sheet No. 12
LIMIT OF CONTRACTORS WORK AREA
Area of Additional Paving
OTTER BROOK
BORROW AREA "C"
EAST ACCESS ROAD
Culvert Sta.16+08 - 53G - 18" RC Pipe 2'x4' Drop Inlet and Conc. Headwall
Note: For Details of this area see Sheet No. 12.
Road Relocation
LIMIT OF CONTRACTOR'S WORK AREA
PLAN
SCALE IN FEET
100 0 100 200
NOTES
Contour intervals 5 feet
Elevations refer to Mean Sea Level Datum
Figures in hexagons indicate item numbers under which payment will be made
Final Field Corrections
Note revised (Add # 4)
Note revised (Add # 5)
Fire fighting facilities deleted (Add #1)
4/15/58 Bridge Abutment revised
CORPS OF ENGINEERS U. S. ARMY
CONNECTICUT RIVER FLOOD CONTROL
OTTER BROOK DAM
GENERAL PLAN
OTTER BROOK, NEW HAMPSHIRE
CT-1-4087


PLAN
SCALE 1" = 10'
INTAKE CHANNEL
SERVICE BRIDGE
STILLING BASIN
OUTLET CHANNEL
OTTER BROOK
Flow
Limit of grading
Magnetic North 1955
PROFILE ALONG ℄ OUTLET WORKS
SCALE 1" = 30'
ELEVATION IN FEET ABOVE M.S.L.
℄ TOWER
GATE HOUSE
SERVICE BRIDGE
℄ PIER
℄ DAM
Top of Dam, El. 802.0
Max. Surcharge, El. 797.1
Spillway Crest, El. 781.0
Conservation Pool El. 701.0
Existing Ground Surface
Approx. Rock Surface
Approximate Top of Rock
Impervious
Pervious
6' Rock fill
2' Rock Fill
3' Gravel Fill
Stop log slot
Transition, for details see sheets Nos. 17 and 18
DETAIL "A"
SCALE 1" = 5'
DETAIL "B"
SCALE 1" = 10'
SECTION A-A
SECTION B-B SIMILAR
SCALE 1" = 10'
HALF PLAN OF
TO SERVICE
CORPS OF ENGINEERS U.S. ARMY
CONNECTICUT RIVER FLOOD CONTROL
OTTER BROOK DAM
OUTLET WORKS
PLAN, PROFILE & SECTIONS
OTTER BROOK
NEW HAMPSHIRE





LEGEND

1.2 / 0.5	HOURS FROM START OF FAILURE TO PEAK STAGE / HOURS TO INITIAL RIVER RISE	▲	EXPERIENCED SEPTEMBER 1938 FLOOD HIGH WATER MARKS
	LIMITS OF BREACH FLOOD	⊙	EXPERIENCED MARCH 1936 FLOOD HIGH WATER MARKS
— M1	RIVER MILES DOWNSTREAM FROM OTTER BROOK DAM	I	BRIDGE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

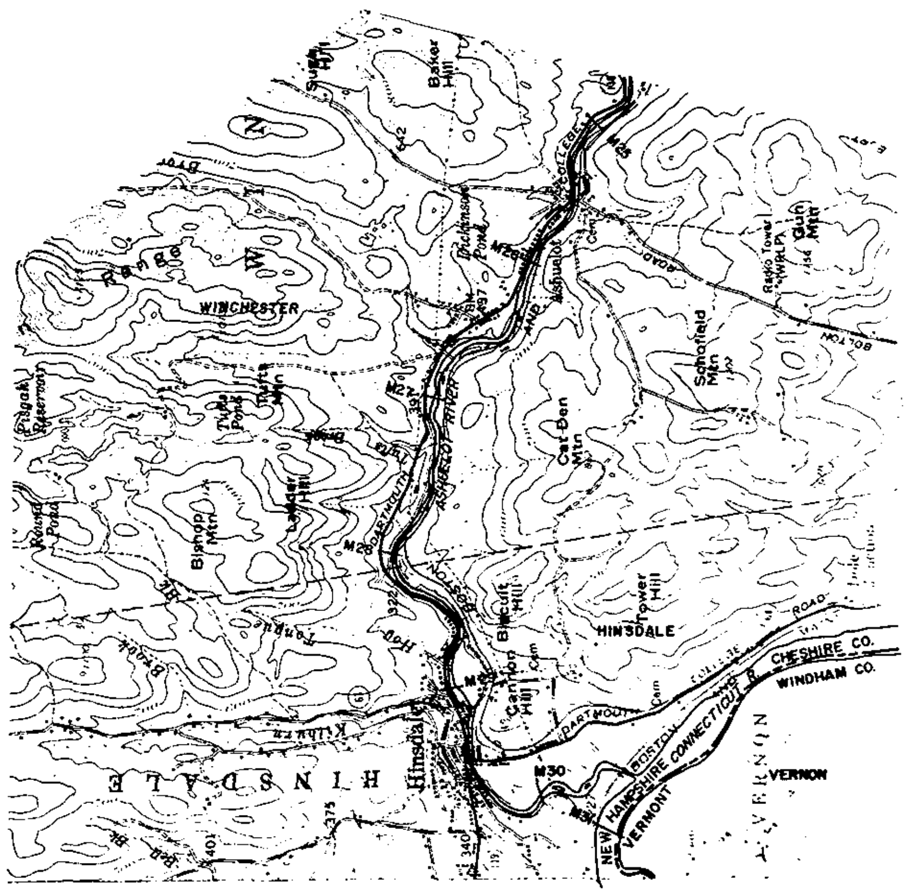
CONNECTICUT RIVER BASIN

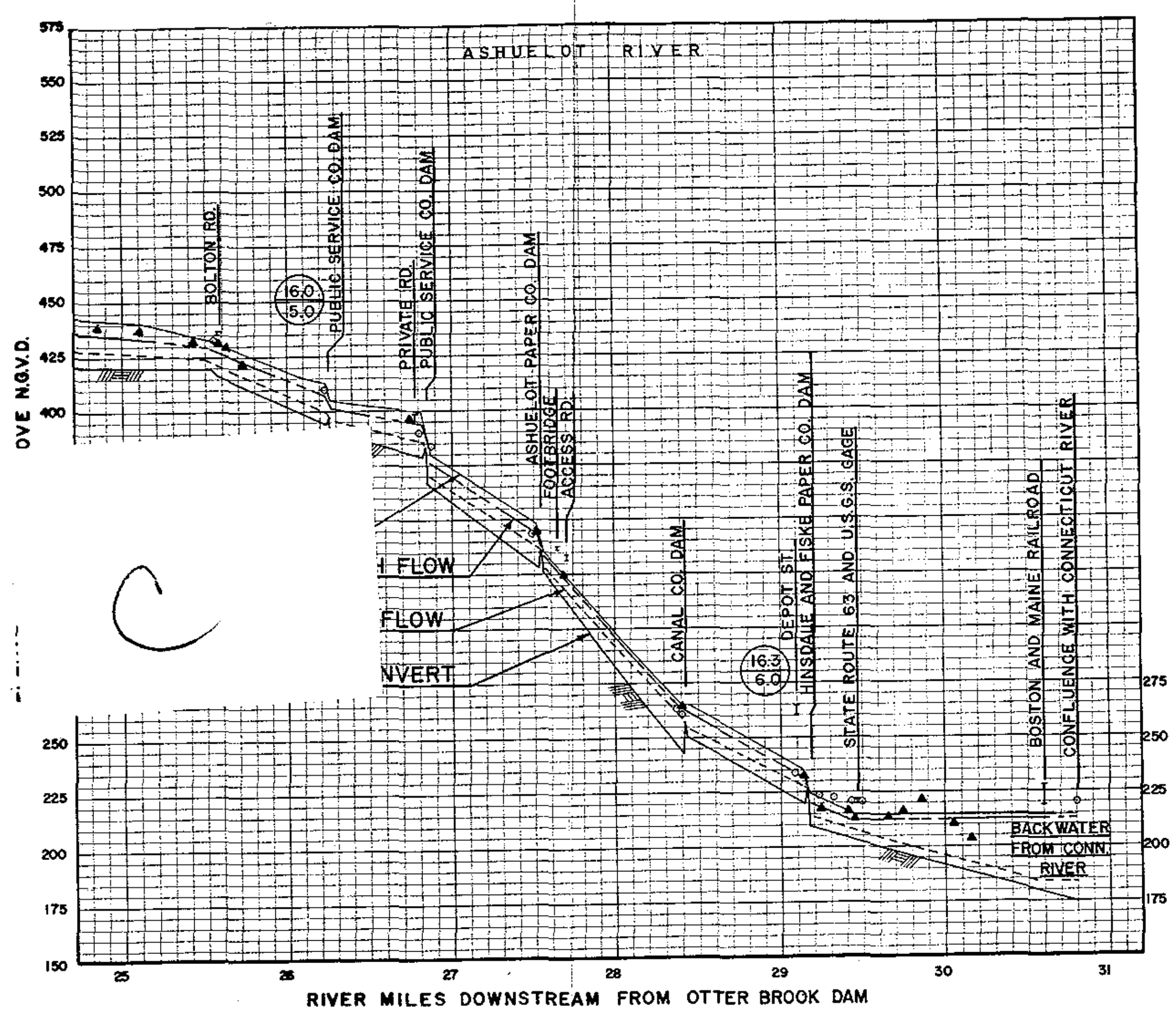
OTTER BROOK DAM BREACH FLOOD

PLAN AND PROFILE NO. 1

HYDRAULICS AND WATER QUALITY SECT AUGUST 1985

PLATE 6





SCALE IN MILES

0.0 0.5 1.0

For Legend see Plate 6

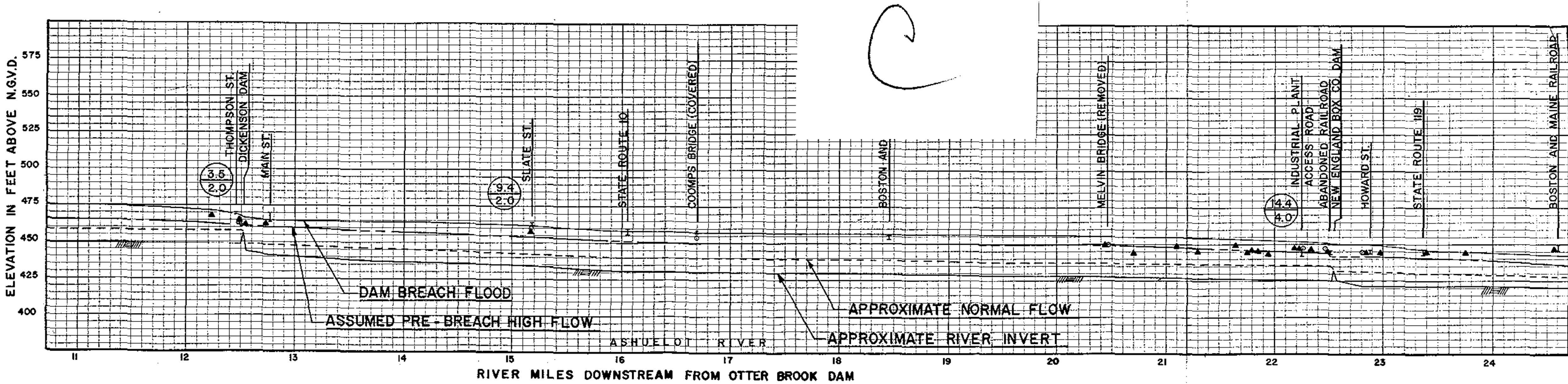
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER BASIN

OTTER BROOK DAM BREACH FLOOD

PLAN AND PROFILE NO. 3

HYDRAULICS AND WATER QUALITY SECT. AUGUST 1965



SCALE IN MILES
0 0.5 1.0

For Legend see Plate 6

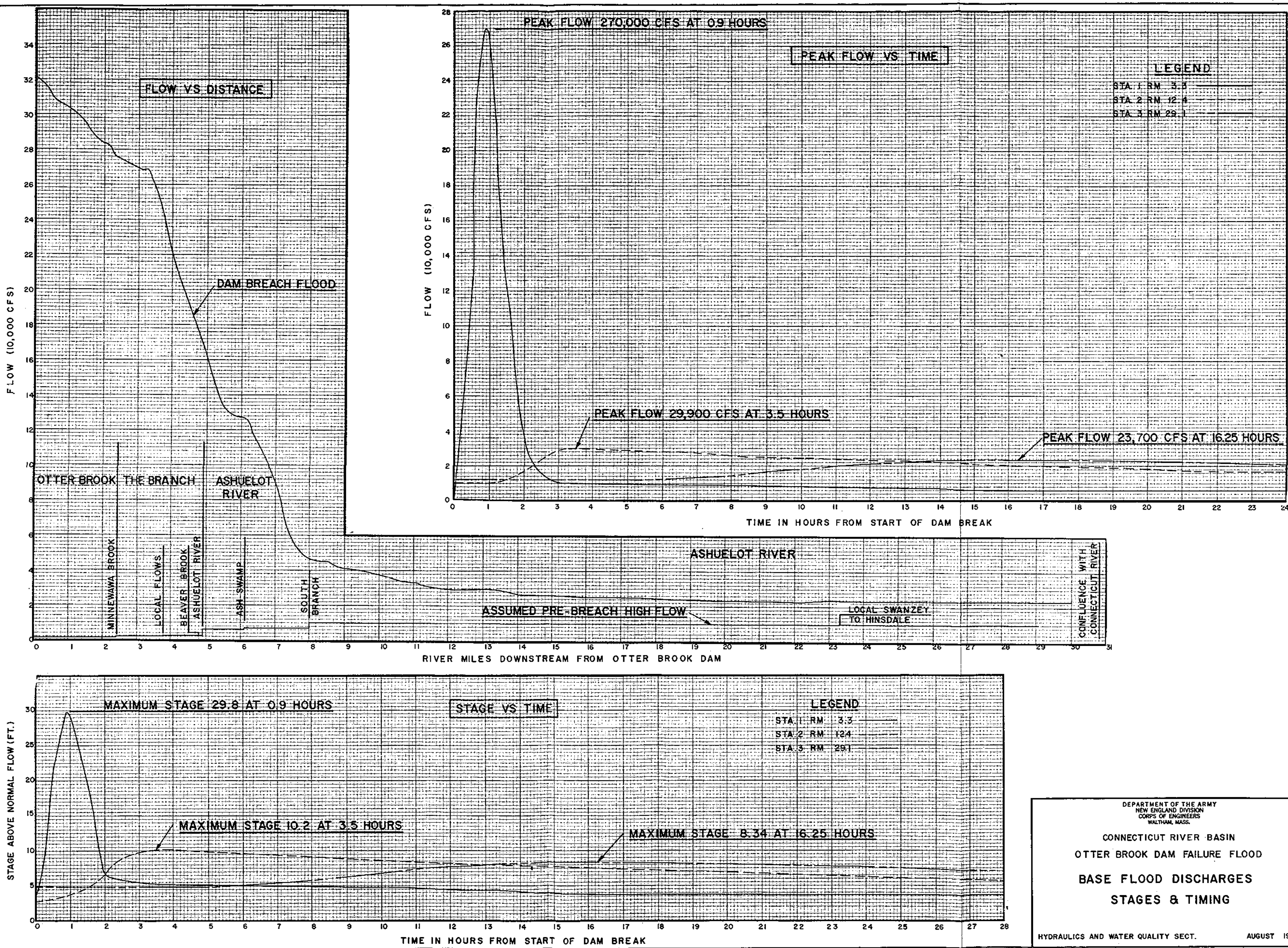
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER BASIN

OTTER BROOK DAM BREACH FLOOD

PLAN AND PROFILE NO. 2

HYDRAULICS AND WATER QUALITY SECT. AUGUST 1985



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

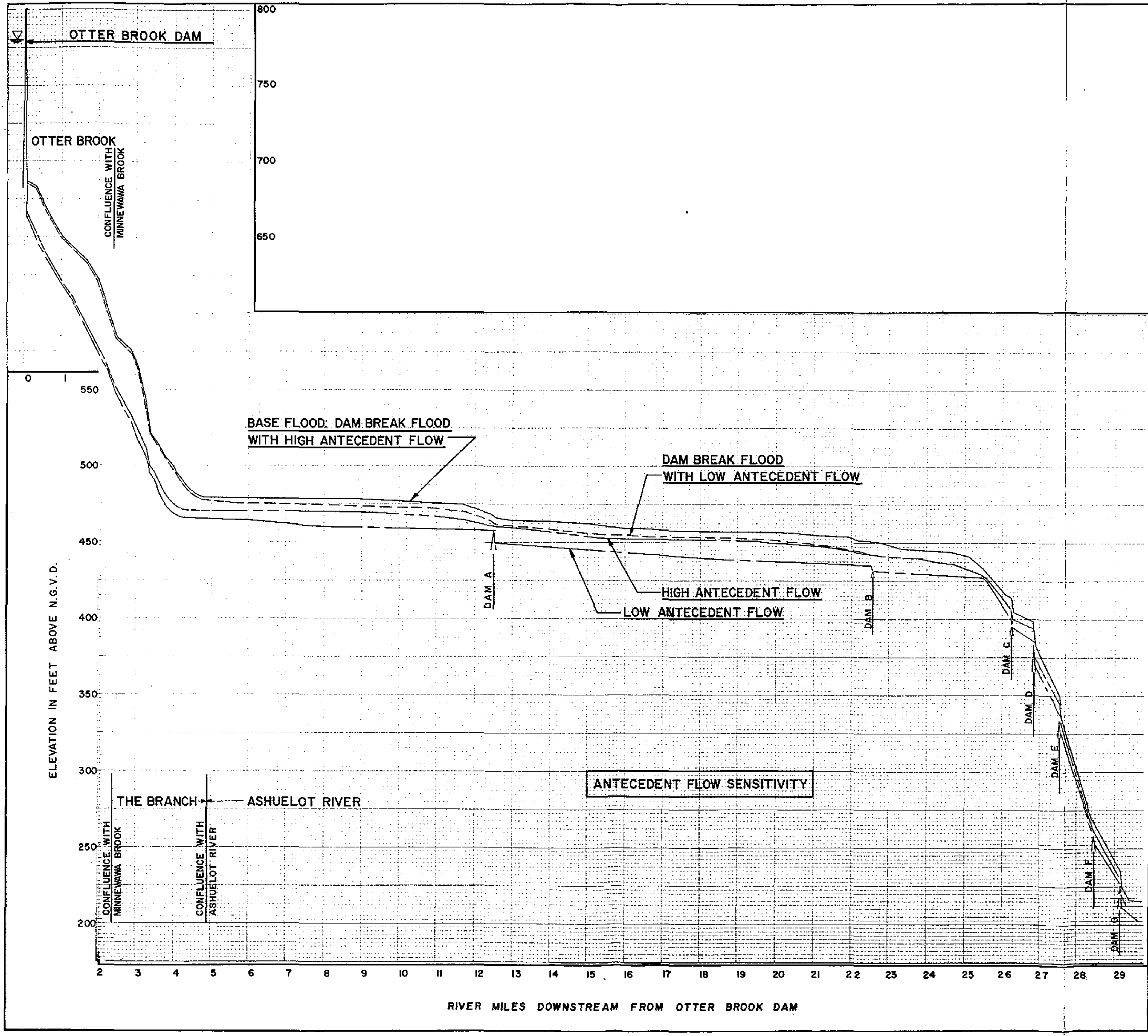
CONNECTICUT RIVER BASIN

OTTER BROOK DAM FAILURE FLOOD

BASE FLOOD DISCHARGES
STAGES & TIMING

HYDRAULICS AND WATER QUALITY SECT. AUGUST 1985

PLATE 9



LEGEND	
DAM	NAME
A	DICKINSON DAM
B	NEW ENGLAND BOX CO. DAM
C	PUBLIC SERVICE CO. DAM
D	PUBLIC SERVICE CO. DAM
E	ASHUELOT PAPER CO. DAM
F	THE CANAL CO. DAM
G	HINSDALE AND FISKE PAPER COMPANY DAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

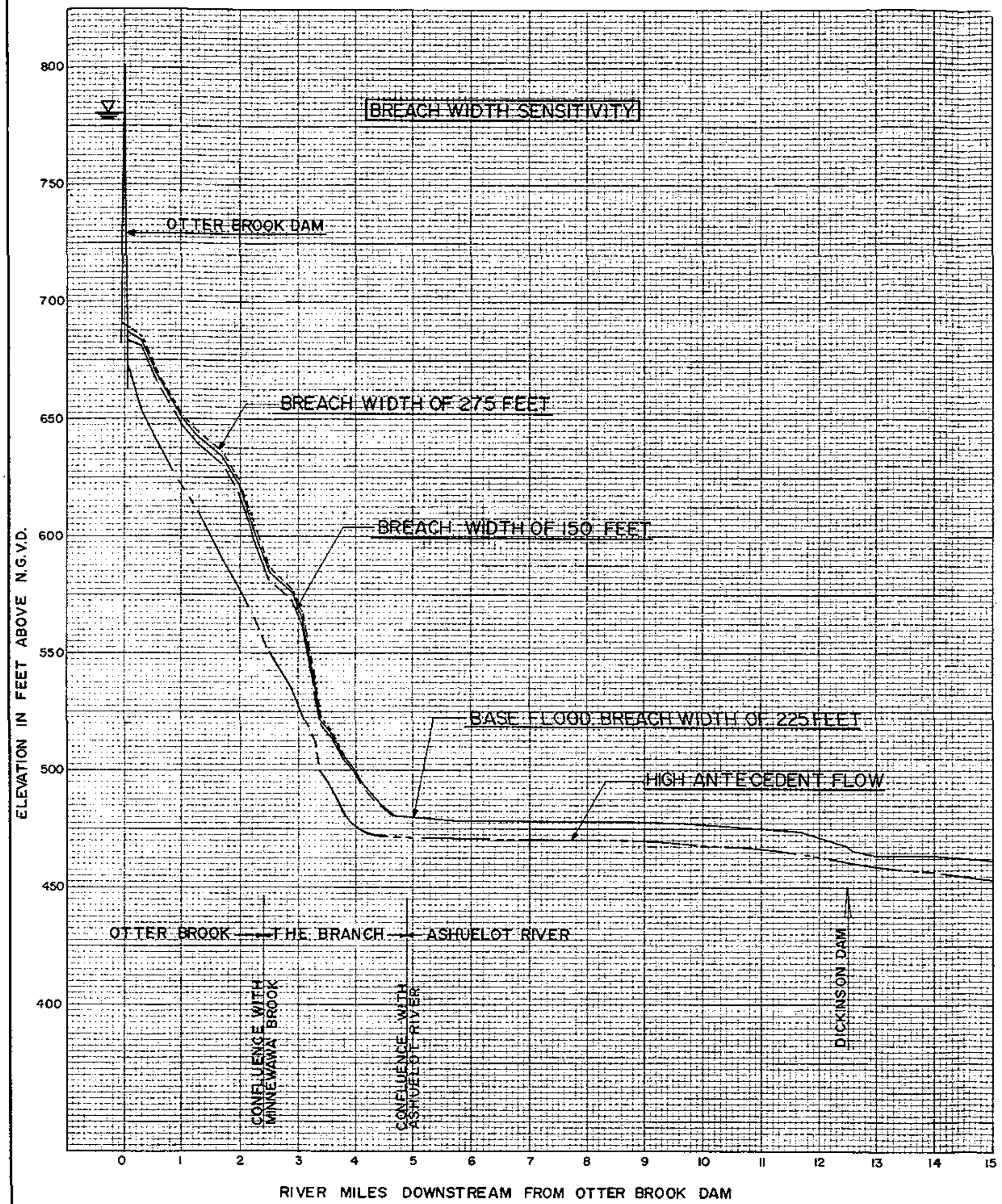
CONNECTICUT RIVER BASIN

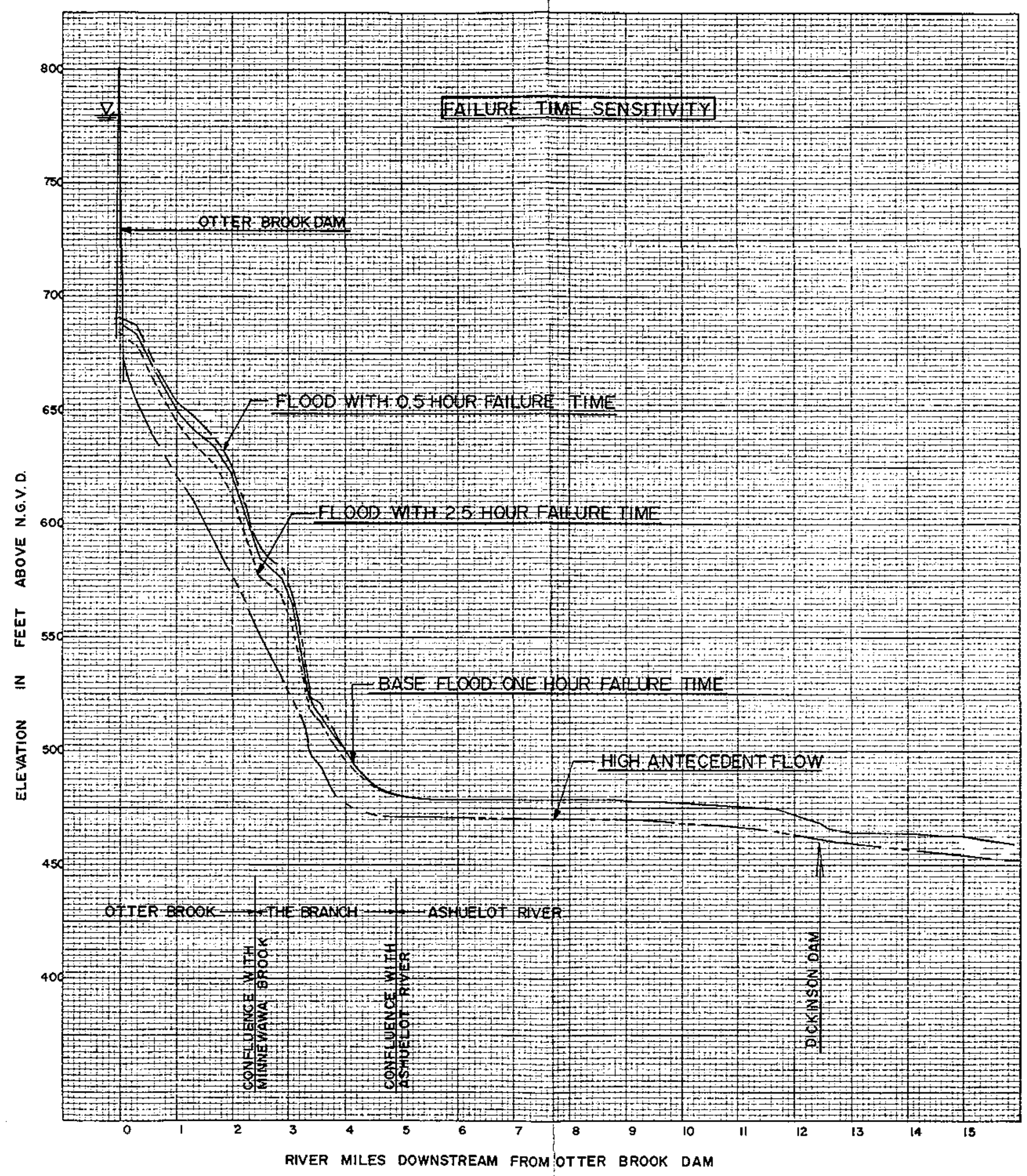
OTTER BROOK DAM FAILURE FLOOD

SENSITIVITY OF INPUT PARAMETERS #1

HYDRAULICS AND WATER QUALITY SECTION AUGUST 1985

PLATE 10





DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

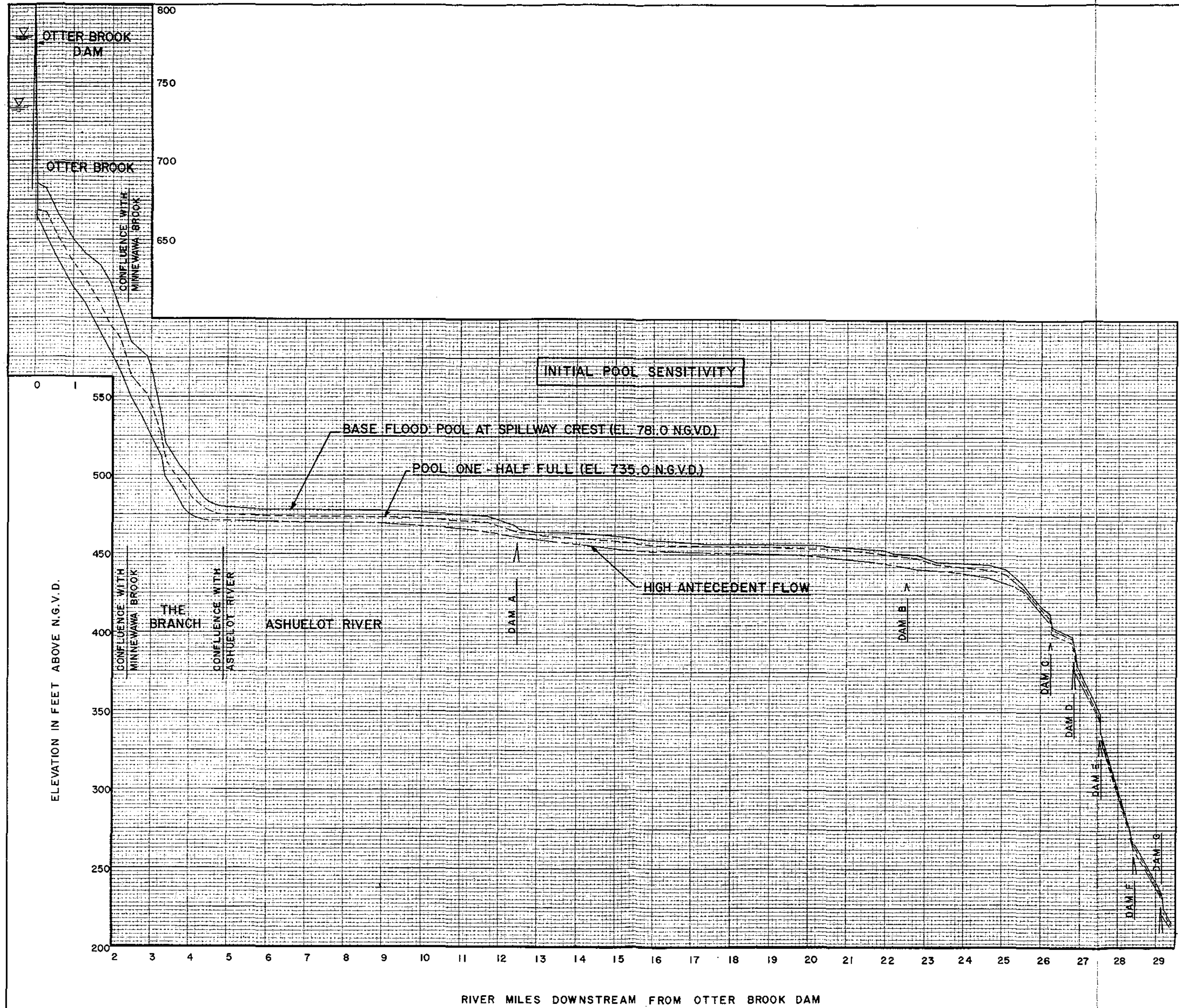
CONNECTICUT RIVER BASIN

OTTER BROOK DAM FAILURE FLOOD

SENSITIVITY OF INPUT PARAMETERS #2

HYDRAULICS AND WATER QUALITY SECTION — AUGUST 1985

PLATE 11



LEGEND	
DAM	NAME
A	DICKINSON DAM
B	NEW ENGLAND BOX CO. DAM
C	PUBLIC SERVICE CO. DAM
D	PUBLIC SERVICE CO. DAM
E	ASHUELOT PAPER CO. DAM
F	THE CANAL CO. DAM
G	HINSDALE AND FISKE PAPER COMPANY DAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

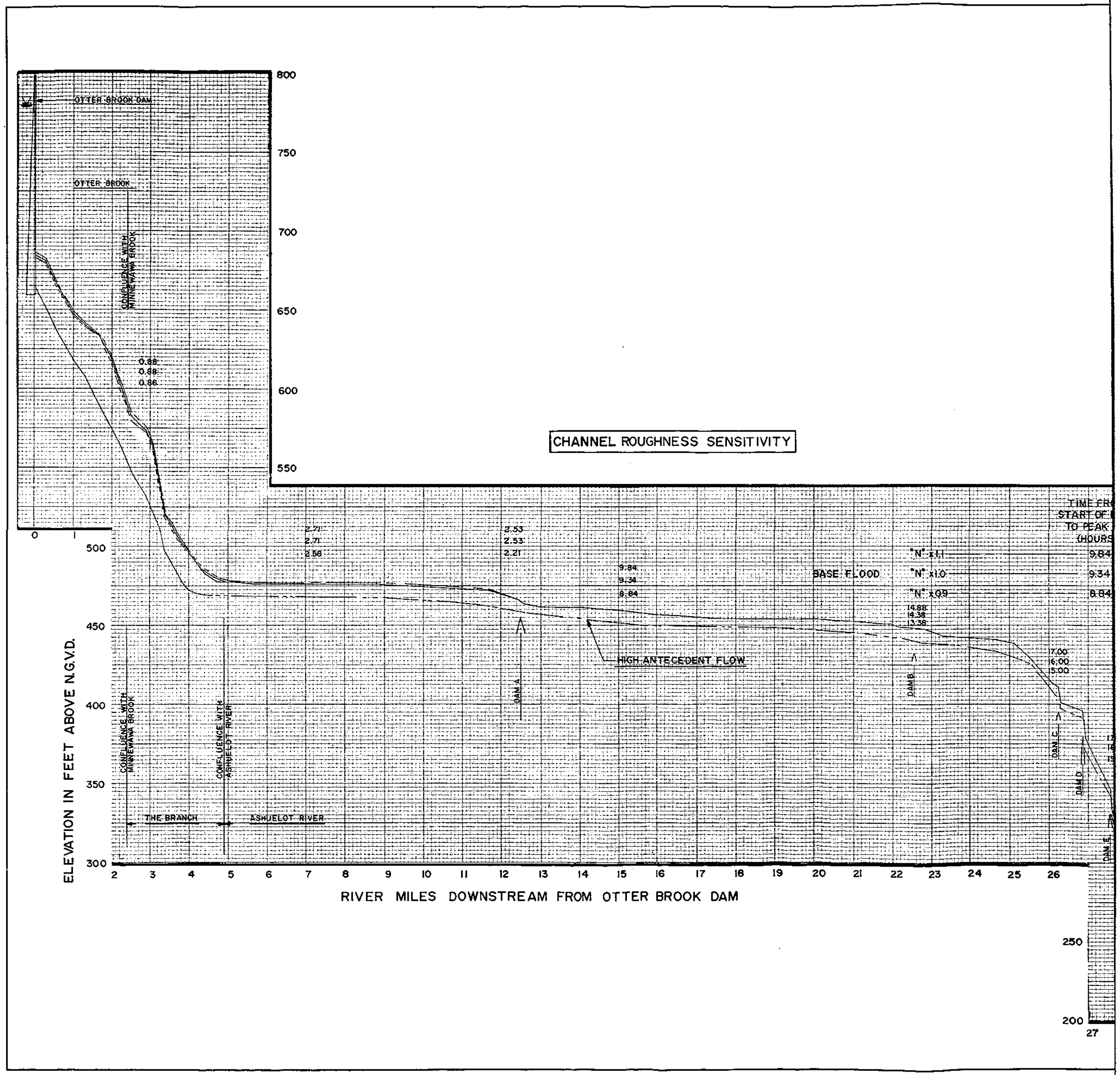
CONNECTICUT RIVER BASIN

OTTER BROOK DAM FAILURE FLOOD

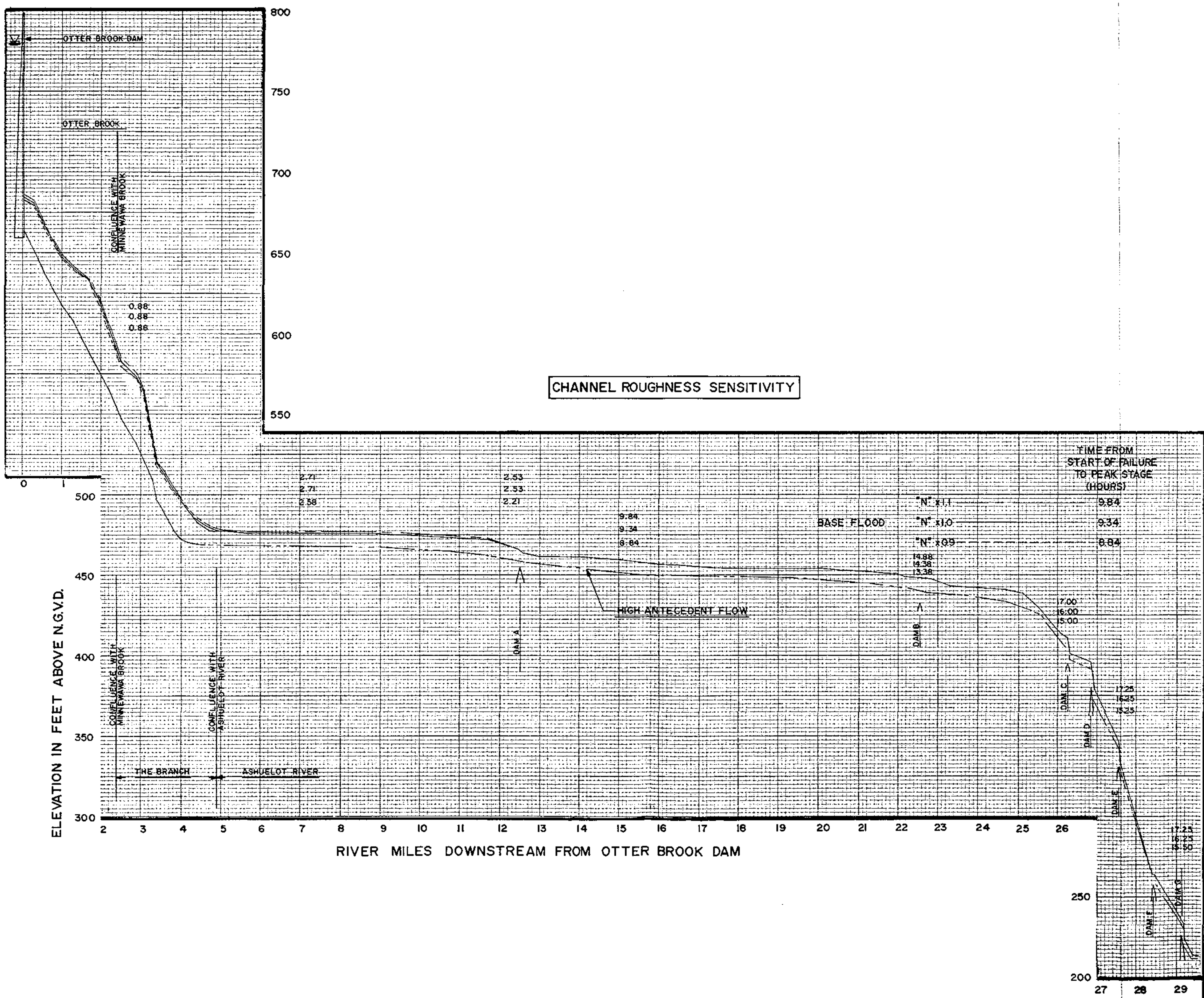
SENSITIVITY OF INPUT PARAMETERS #3

HYDRAULICS AND WATER QUALITY SECTION — AUGUST 1985

PLATE 12



CHANNEL ROUGHNESS SENSITIVITY
OTTER BROOK DAM
OTTER BROOK
CONFLUENCE WITH MINNEWAWA BROOK
CONFLUENCE WITH ASHUELOT RIVER
THE BRANCH
ASHUELOT RIVER
BASE FLOOD
"N" x1.1
"N" x1.0
"N" x0.9
HIGH ANTECEDENT FLOW
DAM A
DAM B
DAM C
DAM D
DAM E
TIME FR
START OF
TO PEAK
(HOURS
9.84
9.34
8.84
ELEVATION IN FEET ABOVE N.G.V.D.
RIVER MILES DOWNSTREAM FROM OTTER BROOK DAM



LEGEND	
DAM	NAME
A	DICKINSON DAM
B	NEW ENGLAND BOX CO. DAM
C	PUBLIC SERVICE CO. DAM
D	PUBLIC SERVICE CO. DAM
E	ASHUELOT PAPER CO. DAM
F	THE CANAL CO. DAM
G	HINSDALE AND FISKE PAPER COMPANY DAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER BASIN

OTTER BROOK DAM FAILURE FLOOD

SENSITIVITY OF INPUT PARAMETERS #4

HYDRAULICS AND WATER QUALITY SECTION AUGUST 1985

PLATE 13

REACH A

```
*HECFORMAT
*ECHO
*FORMATTED
*10FIELDS
ID  OTTER BROOK LAKE
ID  OTTER BROOK FAILURE*
ID  D. STRICKLAND  NED
ID  115N 424 TRAPELO RD
ID  WALTHAM MA 02254
IO      1       17
IP      3        1
IT      1        1
QI   6150     5890     5310     4980     4750     5170     5310     4900     4340     2910
QI   1880     1060      898      659
QT      0        1        2        3        4        5        6        8       10       18
QT     24       28       36       44
SN OTTER   BROOK       DAM
SE    797      781      771      761      751      731      715      683
SA    444      374      327      288      252      192      123        0
DN OTTER   BROOK       DAM
DD    797      781        0      781       43    0.040      683
DB      1      781      225      688      0.5
DO   1500      435
RN   OTTER BROOK DAM TO DICKINSON DAM
RP      1                -1
RG      1        2        3        4        5
RC   0.25
RH  589.7    590.5    592.3    594.7    596.4    597.8    599.1    600.3
RQ   1500     2250     5000    10000    15000    20000    25000    30000
XI   0.25    29.95      655
XE    648      655      675      680      700      725      750      775
XC     50      380      950     1080     1350     1650     1790     1860
NC   .085     .085     .085     .085     .085     .085     .085     .085
XI   0.54    29.66      650
XE    635      650      675      690      700      725      750      775
XC     60      810     1100     1220     1300     1450     1650     1760
NC   .085     .085     .085     .085     .085     .085     .085     .085
QN    .54             LOCAL-1   AREA = 3 SQ. MI.
QL    290      300      315      320      320      280      260      245      245      165
QL    120       75       60       45
XI    .97    29.23      630
XE    617      625      635      650      675      695      700      725
XC     50      650     1200     1400     1910     2170     2280     2400
NC   .085     .085     .085     .085     .085     .085     .085     .085
XI   1.23    28.97      625
XE    607      615      625      635      650      675      700      725
XC     60      550      870     1220     1390     1570     1660     1850
NC   .085     .085     .085     .085     .085     .085     .085     .085
QN   1.23             LOCAL-2   AREA = 10 SQ. MI.
QL   1000     1040     1070     1090     1080      960      880      835      825      560
QL    420      260      204      150
XI   1.58    28.62      605
XE    587      605      625      635      650      675      700      710
XC     60      670      820     1040     1200     1450     1720     2020
NC   .085     .085     .085     .085     .085     .085     .085     .085
*CATEGORICAL
XM    .12      .12      .12      .12      .12      .12      .12
ZZ
```

REACH B

OTTER BROOK DAM-BBB   OTTER BROOK   D. STRICKLAND
BLDG 115N 424 TRAPELO RD   WALTHAM MA 02254

9	0	0	3	40	0	0	0
0.0	40						
2790	180189	289290	223722	53979	13911	7486	6634
6285	6144	6193	6323	6380	6404	6338	6219
6102	5988	5859	5717	5575	5428	5301	5185
5079	4970	4858	4747	4637	4527	4416	4306
4196	4085	3000					
0.0	0.5	0.7	1.0	1.5	2.0	2.5	3.0
4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5
8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5
12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
16.0	16.5	40.0					
11	8	-6	1	0	0	3	0
1	4	5	8	9	11		
1.58	605						
587	605	625	635	650	675	700	710
60	670	820	1040	1200	1450	1720	2020
1.82	590						
573	580	595	610	630	650	670	685
60	180	330	430	700	1140	1320	1370
1.98	580						
564.5	580	590	600	625	650	660	670
60	400	460	500	800	1210	1410	1520
2.09	580						
558	575	595	600	625	650	665	675
60	290	890	890	890	1000	1200	1400
0	0	0	260	790	1310	1700	1810
2.36	565						
544	560	575	600	625	650	655	665
80	480	550	680	860	1400	1400	1400
0	0	0	0	0	0	200	200
2.65	540						
527	540	550	575	600	625	635	650
70	500	610	880	940	1240	1300	2200
2.93	535						
514	525	530	550	575	600	605	610
70	280	420	510	620	800	900	1000
3.16	525						
504	510	520	530	550	575	600	625
80	220	370	490	700	910	1200	1900
3.33	495						
493	498	500	505	520	540	560	580
80	250	1000	1200	1300	1400	1400	1400
0	0	600	900	2600	3000	4000	5000
3.45	491						
487	490	495	500	505	520	540	560
80	280	1000	1100	1200	1400	1400	1400
0	400	600	2900	3600	5600	8200	10000
3.71	484						
472	480	485	490	500	510	520	540

Plate 14B

80	200	700	1200	1300	1400	1400	1400
0	0	400	1300	4500	5400	12800	13900
.060	.060	.060	.100	.100	.100	.100	.100
.07	.07	.07	.11	.11	.11	.11	.11
.07	.07	.07	.11	.11	.11	.11	.11
.08	.08	.08	.12	.12	.12	.12	.12
.08	.08	.08	.12	.12	.12	.12	.12
.08	.08	.08	.12	.12	.12	.12	.12
.08	.08	.08	.12	.12	.12	.12	.12
.08	.08	.08	.12	.12	.12	.12	.12
.08	.08	.08	.12	.12	.12	.12	.12
.08	.08	.08	.12	.12	.12	.12	.12
.15	.15	.15	.15	.15	.15	.15	.15
.15	.15						
					.1		-.65

0	0	0	0.				
4	5	9					
3230	3300	3330	3360	3410	3460	3460	3460
3490	3330	3170	3000	2855	2815	2775	2735
2695	2690	2685	2680	2670	2610	2560	2510
2445	2400	2360	2320	2290	2200	2110	2020
1925	1840	570					
175	180	185	190	195	195	193	192
190	180	170	160	155	153	150	150
145	145	145	145	145	140	140	135
130	130	130	125	125	120	115	110
105	100	30					
100	101	103	104	105	106	108	109
110	100	95	90	85	85	83	83
80	80	80	80	80	80	77	77
75	74	74	72	70	70	65	65
60	60	15					

EOT..

Plate 14C

REACH C

```
*HECFORMAT
*ECHO
*FREEFORMATTED
*COMPOSITE
ID,OTTER BROOK TO CONN. R.
ID,ASHUELOT RIVER
ID,D STRICKLAND  NED-COE
ID,BLDG 115N  424 TRAPELO RD
ID,WALTHAM MA 02254
IO,9,31
IP,3,1
QI,3700,3700,3700,3700,3700,3700,3700,3700,3700,3700
QI,3700,3700,3700,3700,3700,3700,3700,3700,3700,3700
QI,3700,3700,3700,3700,3700,3700,3700,3700,3700,3700
QT,0,.1,.5,1.0,1.1,1.5,2.0,2.5,3.0,3.5
QT,4.0,4.5,5.0,6.0,7.0,8.0,9.0,10.0,11.0,12.0
QT,14.0,16.0,18.0,20.0,23.0,35.0,47.0,59.0,71,83
SN,SURRY MOUNTAIN DAM
SE,558,541,531,521,511,501,491,485
SA,1100,862,722,580,438,278,85,0
DN,SURRY MOUNTAIN DAM
DD,568,550,,550,2.5,.040,485
DB,1,999,200,490,.5
DO,3700,1082
DN,FAULKNER AND COLONY DAM
DD,476,472,,476.02,1.5,.040,464.2
DB,.5,999,130,464.2
DQ,0,1200,2000,6500,8800,25000,76000,200000
DH,0,2,3.3,5.2,5.8,7.9,10.1,12
DN,DICKINSON DAM
DD,457,456.2,,460.85,5.8,.040,443.5
DB,.5,999,167,443.5
DQ,0,1000,2500,4400,13000,17000,30000,59000
DH,0,1,2,3,6.5,8.3,12,16.5
DN,NEW ENGLAND BOX CO. DAM
DD,432.6,,,442.9,2.5,.040,426
DB,.5,999,103,426
DO,,,,323
DN,PUBLIC SERVICE CO. DAM 1
DD,396.5,,,407.1,31.7,.040,391
DB,.5,999,100,391
DO,,,,343
DN,PUBLIC SERVICE CO. DAM 2
DD,383.1,,,393.7,52.8,.040,365
DB,.5,999,100,365
DO,,,,341
DN,ASHUELOT PAPER CO. DAM
DD,335.7,,,343.5,68.6,.040,326
DB,.5,999,100,326
DO,,,,546
DN,THE CANAL CO. DAM
DD,258.2,,,263.3,52.8,.040,250
DB,.5,999,100,250
DO,,,,1012
```

Plate 14D

```
DN,HINSDALE AND FISKE PAPER CO. DAM
DD,226,,,231.9,42.2,.040,211
DB,.5,999,100,211
DO,,,,828
DN,USGS GAGE
DD,203,203,,210.8,38.9,,.040,203
DQ,0,31,890,1880,3420,8300,16200,40000
DH,0,1,3,4,5,7,9.69,17.79
RN,SURRY MOUNTAIN DAM TO FAULKNER AND COLONY DAM
RP,1,,-1
RG,1,3,5,7,9,12
RC,476.02,0,0,,.063
XI,0.1,34,488
XE,484,488,490,494,505,516,518,534
XC,55,120,415,735,825,915,1035,1415
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,0.8,33.14,487
XE,482,486,488,492,503,514,516,532
XC,55,120,415,735,825,915,1035,1415
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,1.45,32.07,485
XE,480,485,486,488,490,504,514,530
XC,70,100,730,1840,1865,2050,2345,2950
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,1.7,31.11,482
XE,479,482,484,486,490,500,510,518
XC,38,40,1015,1700,1990,2110,2240,2535
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,2,30.86,479
XE,477,478,480,484,486,500,504,514
XC,55,70,320,975,1255,1350,1400,1625
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,2.18,30.56,481
XE,476,480,482,484,488,490,492,516
XE,476,480,482,484,488,490,492,516
XC,55,90,620,660,1165,1220,1300,1540
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,2.55,30.05,480
XE,475,476,480,484,490,494,500,515
XC,80,145,510,780,970,1290,1420,2080
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,2.87,29.57,477
XE,474,476,478,480,482,490,495,500
XC,60,110,265,620,635,665,680,700
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,3.35,28.87,480
XE,473,476,480,482,486,490,495,500
XC,80,100,215,625,830,830,830,830
XO,0,0,0,0,0,490,1720,2680
NC,.035,.035,.045,.045,.045,.045,.045,.045
XI,3.5,28.71,479
XE,472.6,475,478,480,485,490,495,500
XC,50,70,90,1240,1400,1400,1400,1400
XO,0,0,0,0,0,1430,3110,4800
NC,.025,.025,.040,.040,.040,.040,.040,.040
XI,4.05,27.8,475
XE,472.3,474,476,478,484,490,492,498
XC,120,125,1580,1800,1960,1960,1960,1960
XO,0,0,0,0,0,280,480,600
NC,.025,.025,.040,.040,.040,.040,.040,.040
```

```
XI,4.5,27.39,475
XE,472,474,476,478,480,482,486,500
XC,180,220,2520,2760,2800,2900,2900,2900
XO,0,0,0,0,0,0,1202,1300
NC,.025,.025,.040,.040,.040,.040,.040,.040
*CATEGORICAL
XM,.25,.25,.25,.25,.25,.25,.25,.25,.25,.25
XM,.25,.25
*COMPOSITE
RN,FAULKNER AND COLONY DAM TO DICKINSON DAM
RP,1,,-1
RG,1,4,5,8,9,14
RC,460.85,-0.1698,40000,.063
XI,4.65,27.18,471
XE,464.2,470,472,474,476,478,480,500
XC,195,230,345,470,2600,2600,2600,2600
XO,0,0,0,0,1878,4704,6950,7340
NC,.020,.020,.035,.035,.035,.035,.035,.035
XI,5.08,26.59,471
XE,464.1,470,472,473,474,476,480,500
XC,105,135,405,715,2071,2071,2071,2071
XO,0,0,0,0,0,1973,10309,11459
NC,.020,.020,.035,.035,.035,.035,.035,.035
XI,5.25,26.46,470
XE,464,469,470,472,474,476,480,500
XC,60,80,165,930,2695,2695,2695,2695
XO,0,0,0,0,0,3605,10455,11655
NC,.020,.020,.020,.035,.035,.035,.035,.035
XI,5.69,25.73,467
XE,460.2,466,468,469,470,472,480,500
XC,60,85,550,1520,2410,2410,2410,2410
XO,0,0,0,0,0,1210,9528,11368
NC,.020,.020,.035,.035,.035,.035,.035,.035
QN,5.69,,THE BRANCH
QL,2593,7295,28660,229565,238630,180740,72580,27472,14430,11570
QL,11324,11055,10705,10415,10300,10020,9740,9455,9060,8665
QL,7990,7130,6980,6875,6740,6500,6400,6345,6320,6300
XI,5.84,25.62,464
XE,460.1,462,466,468,472,476,480,500
XC,60,70,430,1610,2400,2400,2400,2400
XO,0,0,0,0,1847,5123,7800,9450
NC,.020,.020,.035,.035,.035,.035,.035,.035
XI,6.4,25.05,465
XE,460,462,464,466,467,470,480,500
XC,70,90,110,1160,1240,1968,1968,1968
XO,0,0,0,0,0,0,2432,3224
NC,.020,.020,.020,.035,.035,.035,.035,.035
QN,6.4,,ASH SWAMP BROOK + LOCAL
QL,744,3000,2950,2900,2890,2850,2800,2750,2700,2600
QL,2500,2440,2380,2300,2200,2100,2000,1900,1800,1700
QL,1500,1400,1200,1100,900,500,400,300,250,200
XI,7.75,23.7,456.5
XE,452.7,453.2,456.5,460,470,471,480,500
XC,20,50,100,200,2940,2940,2940,2940
XO,0,0,0,0,0,1300,3140,3510
NC,.020,.020,.020,.035,.035,.035,.035,.035
XI,8.43,23.02,461
XE,452.6,453.2,461,462,470,471,480,500
XC,20,80,130,1800,3000,3000,3000,3000
XO,0,0,0,0,0,1330,2110,2400
```

```
NC,.020,.020,.020,.035,.035,.035,.035,.035
QN,8.43,,SOUTH BRANCH
QL,3482,9000,8650,8300,8230,7950,7600,7250,6900,6650
QL,6400,6200,6000,5800,5600,5400,5200,5000,4800,4500
QL,4000,3600,3200,2900,2300,1400,1000,800,600,500
XI,9.1,22.35,466
XE,452.1,453,466,476,480,484,485,486
XC,0,80,180,580,1020,1240,1450,1540
NC,.020,.020,.020,.035,.035,.035,.035,.035
XI,9.43,22.02,453.5
XE,452,453,453.5,456,456.5,460,485,500
XC,30,60,120,180,250,360,2180,3070
NC,.020,.020,.020,.035,.035,.035,.035,.035
XI,9.67,21.78,456.5
XE,450.2,451.5,456.5,480,481,482,500,500.1
XC,0,75,130,130,1690,1920,2400,2500
NC,.020,.020,.020,.020,.035,.035,.035,.035
XI,10.1,21.35,452
XE,450.1,450.5,452,460,480,482,500,500.1
XC,0,45,80,200,870,1260,3000,30001
NC,.020,.020,.020,.035,.035,.035,.035,.035
XI,12.33,19.12,459.5
XE,448.6,449.5,459.5,460,480,480.1,490,500
XC,0,70,130,210,1270,2080,2120,3500
NC,.020,.020,.020,.035,.035,.035,.035,.035
XI,13.14,18.31,454.5
XE,448.5,450.3,454.5,469,469.1,485.7,488,500
XC,20,50,135,150,340,950,1850,2200
NC,.020,.020,.020,.035,.035,.035,.035,.035
*CATEGORICAL
XM,.25,.25,.25,.25,.25,.25,.25,.25,.25,.25
XM,.25,.25,.25,.25
*COMPOSITE
RN,DICKINSON DAM TO NEW ENGLAND BOX CO. DAM
RP,1,,-1
RC,442.9,0,0,.25
RG,1,2,3,5,6,8
XI,13.19,18.26,447
XE,443.4,446,447,460,461,480,487,500
XC,0,150,168,180,510,1020,2050,2500
NC,.030,.030,.030,.040,.040,.040,.040,.040
XI,13.4,18.05,444
XE,440.8,443,444,457,460,470,473,476
XC,0,70,130,180,520,880,1150,2200
NC,.030,.030,.030,.040,.040,.040,.040,.040
XI,14.41,17.04,447.5
XE,437.3,437.7,447.5,452.5,455.5,460,475,485.6
XC,0,20,100,150,1300,2820,3370,3650
NC,.030,.030,.030,.040,.040,.040,.040,.040
XI,15.66,15.79,443
XE,435,436,442,443,460,461,473,483
XC,15,50,90,140,320,430,850,1025
NC,.030,.030,.030,.040,.040,.040,.040,.040
XI,16.53,14.92,437
XE,431,434,435,437,441,455,460,475
XC,15,45,65,90,135,250,1050,1380
NC,.025,.025,.025,.035,.035,.035,.035,.035
XI,20.39,11.06,433
XE,429,430,431,433,446,450,460,480
XC,15,45,75,105,540,2300,3080,5800
```

```
NC,.025,.025,.025,.035,.035,.035,.035,.035
XI,20.73,10.72,433
XE,428.9,430,430.5,433,444,453,460,480
XC,10,40,70,100,180,695,1655,3168
NC,.025,.025,.025,.035,.035,.035,.035,.035
XI,23.16,8.29,432
XE,426,427,428,432,446,447,460,480
XC,0,35,60,115,120,410,1440,1650
NC,.025,.025,.025,.035,.035,.035,.035,.035
*CATEGORICAL
XM,.25,.25,.25,.25,.25,.25,.25,.25
*COMPOSITE
RN,NEW ENGLAND BOX CO. DAM TO P. S. CO. DAM 1
RP,1,,-1
RC,407.1,0,0,.25
RG,2,3,4,5,6,7
XI,23.22,8.23,428
XE,425.9,427,428,442,443,450,460,480
XC,0,90,100,210,235,730,1420,1640
NC,.020,.020,.020,.035,.035,.035,.035,.035
XI,23.46,7.99,426
XE,421.9,422,423,426,443,446,452,487
XC,0,15,55,80,115,750,1040,1350
NC,.040,.040,.040,.060,.060,.060,.060,.060
QN,23.46,,LOCAL SWANZEY TO HINSDALE
QL,1123,900,875,850,845,825,800,775,750,725
QL,700,690,685,680,655,625,610,600,600,590
QL,500,500,480,450,400,300,250,200,150,100
QL,150,150,200,600,2000,1100,1100,1000,750,700
QL,600,400,300,250,200,150,100
XI,23.96,7.49,437
XE,421.8,425,430,437,439,443,460,500
XC,86,113,133,153,280,770,2640,3000
XO,0,0,0,0,0,0,4224,4392
NC,.040,.040,.040,.060,.060,.060,.060,.060
XI,24.46,6.99,425
XE,421.7,423,425,440,460,460.1,460.2,460.3
XC,0,96,130,860,1840,1840,1840,1840
NC,.040,.040,.060,.060,.060,.060,.060,.060
XI,26.17,5.28,422
XE,420,422,435,445,450,450.1,450.2,450.3
XC,98,155,258,818,977,977,977,977
NC,.040,.060,.060,.060,.060,.060,.060,.060
XI,26.22,5.23,419
XE,417,419,420,425,430,435,450,450.1
XC,22,119,170,195,280,370,680,680
NC,.040,.060,.060,.060,.060,.060,.060,.060
XI,26.9,4.55,396
XE,394,395,396,408,411,440,440.1,440.2
XC,15,68,90,181,294,526,526,526
NC,.040,.040,.060,.060,.060,.060,.060,.060
*CATEGORICAL
XM,.125,.125,.125,.125,.125,.125,.125
*COMPOSITE
RN,P. S. CO. DAM 1 TO DAM 2
RP,1,,-1
RC,393.7,0,0,.25
RG,1,2
XI,26.92,4.53,393
XE,391,393,394,400,411,434,434.1,434.2
```

```
XC,23,100,158,242,371,511,511,511
NC,.040,.050,.050,.050,.050,.050,.050,.050
XI,27.49,3.96,382
XE,379,382,386,400,400.1,400.2,400.3,400.4
XC,34,125,349,500,500,500,500,500
NC,.040,.050,.050,.050,.050,.050,.050,.050
*CATEGORICAL
XM,.05,.05
*COMPOSITE
RN,P. S. CO. DAM 2 TO ASHUELOT PAPER CO. DAM
RP,1,,-1
RC,343.5,0,0,.25
RG,1,2
XI,27.51,3.94,368
XE,367,368,375,400,400.1,400.2,400.3,400.4
XC,76,99,152,504,504,504,504,504
NC,.040,.050,.050,.050,.050,.050,.050,.050
XI,28.19,3.26,342
XE,328,342,371,371.1,371.2,371.3,371.4,371.5
XC,32,122,400,400,400,400,400,400
NC,.040,.050,.050,.050,.050,.050,.050,.050
*CATEGORICAL
XM,.05,.05
*COMPOSITE
RN,ASHUELOT PAPER CO. DAM TO THE CANAL CO. DAM
RP,1,,-1
RC,263.3,0,0,.25
RG,1,2
XI,28.2,3.25,350
XE,326,350,371,371.1,371.2,371.3,371.4,371.5
XC,107,230,300,300,300,300,300,300
NC,.040,.060,.060,.060,.060,.060,.060,.060
XI,29.07,2.38,244
XE,243,244,245,263,275,300,300.1,300.2
XC,60,98,123,179,302,472,472,472
NC,.040,.040,.060,.060,.060,.060,.060,.060
*CATEGORICAL
XM,.05,.05
*COMPOSITE
RN,THE CANAL CO. DAM TO HINSDALE PAPER CO. DAM
RP,1,,-1
RC,231.9,0,0,.25
RG,1,2
XI,29.09,2.36,252
XE,251,252,260,300,300.1,300.2,300.3,300.4
XC,17,83,158,375,375,375,375,375
NC,.040,.040,.060,.060,.060,.060,.060,.060
XI,29.8,1.65,224
XE,220,224,226,228,235,250,250.1,250.2
XC,47,170,178,181,202,680,680,680
NC,.040,.060,.060,.060,.060,.060,.060,.060
*CATEGORICAL
XM,.05,.05
*COMPOSITE
RN,DOWNSTREAM FROM HINSDALE PAPER CO. DAM
RP,1,,-1
RC,210.8,0,0,.25
RG,1,2
XI,29.83,1.62,212
XE,210,212,218,250,250.1,250.2,250.3,250.4
```

```
XC,97,110,173,620,620,620,620,620
NC,.040,.060,.060,.060,.060,.060,.060,.060
XI,30.01,1.44,210
XE,203,205,210,215,220,225,230,240
XC,97,110,140,175,440,535,575,915
NC,.040,.060,.060,.060,.060,.060,.060,.060
*CATEGORICAL
XM,.05,.05
*COMPOSITE
ZZ
```